POWER

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Because "It is Done"

THE habits and customs of a people are influenced, perhaps more than in any other way, by the notion that certain things are "the thing to do" and certain other things "are not done."

Women could not have been forced by a constitutional amendment to the present liberal display of charms once prudishly hidden. But let the notion be established that it is the thing to do and—you see what you see!

Tons of tobacco are burned because, in literature and on the stage, the pipe or a cigar is the natural concomitant of the evening paper or a book by the fireside or because "the duchess lighted another cigarette."

In the pre-Volstead days the most objectionable features of the drinking habit were quietly slipping into disfavor. Promiscuous and habitual drinking were frowned upon and it was getting to be quite the thing to say, "No, I thank you."

Today people who never knew the taste of liquor carry it upon their hips because it is regarded as smart and sporty.

I wonder if there is not some way in which this willing subserviency to Vogue, this motivating power of a state of mind, can be used to bring about needed reforms in the social and industrial structure.

Are there not some things that we are prone to attempt by legislation that might be done more effectively by arousing an expression of general disapproval of objectionable methods or by making desirable practices "the thing to do?"

The state of the public mind and especially the attitude of one's set toward questionable business practices would do more to deter the overreaching individual than any act of any government.

Condemnation by public opinion would cut deeper than the finding of a criminal jury, and to live despised of one's fellow men would be a greater punishment than a term in jail.

What are the influences and activities that can best bring about public reprehension of unmoral and unfair practices and social ostracism for the successful crook?

F. R. Low

Comparative Costs of Industrial Power-Plant Operation

By HAROLD ANDERSON
Engineer, Westinghouse Electric & Manufacturing Company

AN ANALYSIS of four plants, designed for steam pressures ranging from 130 to 600 pounds, shows that up to 400 pounds there is a material gain in the economy of operation over the lower-pressure plants, but beyond this point the economic gain is small.

IN VIEW of the improved thermal efficiency that is obtainable by the use of higher boiler pressures, there has been in recent years a decided trend in the direction of higher pressures both in central stations and in industrial plants. This subject has been discussed in numerous articles, and the theoretical gains obtained from higher steam pressures have been treated in detail, but little has been mentioned concerning the economic side of the question. This is, no doubt, due to the many variables entering into a problem of this kind which tend to make it complicated. If consistent assumptions are made, however, there is no reason why relative figures cannot be derived that will make it entirely feasible to compare costs of operation under different steam conditions.

As a general statement it may be said that industrial plants will benefit greatly by the use of higher steam pressures, in particular those plants that make use of large amounts of process steam, as they will be able to generate most of their power by means of non-condensing machines. Industrial plants using little or no process steam will, however, often be able to purchase power cheaper than it can be generated in an individual plant.

In this article it is proposed to analyze briefly the cost of steam and power generation for a mill requiring 25,000 lb. per hour of process steam at 125 lb. gage and 75,000 lb. per hour at 15 lb. gage. These amounts will change slightly, as outlined in Table I, when operating under different initial conditions. The calculations are primarily based on paper-mill practice, but the general procedure followed is also applicable to rubber factories, chemical plants and many similar industries.

A paper mill was taken because, when operating on a production schedule, its power and steam demands are relatively steady, its usual working time being about 310 days a year each of 24 hours. The high-pressure process steam which is principally used in the digesters, is, of course, subject to hourly fluctuations depending upon the number of digesters used, the cooking time employed, etc., but it is not necessary to take account of fluctuations of this kind in a comparative cost analysis. A strict analysis should take account of all fluctuations, but this would require a discussion of prohibitive length and would not change the conclusions to an appreciable extent.

In calculating Table I, the superheat for the plants under consideration has been so chosen that the final quality of the process steam will in all cases be approximately the same. Any slight difference in B.t.u. value has been taken care of by adjusting the total amounts of steam, so as to obtain the same total heat value. This is probably the most consistent way of obtaining the initial steam conditions, because when the ultimate use of the exhaust steam is for process work, its quality is usually fixed within rather narrow limits. When the primary object is to generate power, it is generally conceded that the proper way is to start from as high a temperature as available materials will permit and allow the quality of the exhaust steam to vary accordingly.

Table I shows the result of the necessary calculations for arriving at the proper size of boiler plant in each

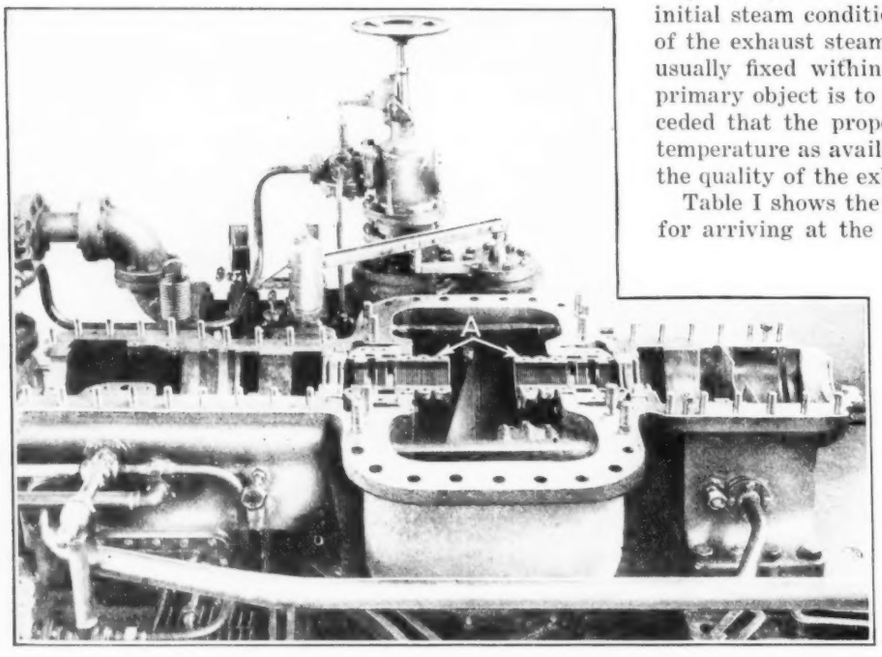

Fig. 1—Lower half of turbine designed for a maximum steam condition of 600 lb. inlet pressure, 750 deg. F. total temperature, 150 lb. back pressure

case. This table also shows both the power generated from process steam and the additional power that must be generated by the turbine steam expanding to a vacuum to obtain the required 5,000 kw. As the initial steam pressure and superheat is increased, the size of the required condensing equipment is decreased as shown in Table I. In general it is not possible, however, to take full advantage of this fact as a certain amount of condensing capacity must be available to enable the turbine to carry the power load when little or no process steam is used. If electric power is obtainable from an outside source, it can be used to take care of power-load fluctuations, but this does not come within the scope of this article and will not be considered further, except to state that the choice in such a case depends entirely on local conditions.

TABLE I—SUMMARY OF STEAM AND POWER REQUIREMENTS

Steam conditions	150 Lb. Dry and Saturated	250 Lb. 75 Deg. F.	400 Lb. 100 Deg. F.	600 Lb. 125 Deg. F.
Steam Requirements, Pounds per Hour				
High-pressure process steam 125-lb. gage.	25,000	24,850	24,800	24,800
Low-pressure process steam 15-lb. gage..	75,000	74,300	73,600	73,550
Steam to condenser 28-in. vacuum.....	49,900	31,200	16,400	6,220
Total steam, lb. per hr.....	149,900	130,350	114,800	104,570
*Power Generation, Kilowatts**				
Power available from steam expanded to 125-lb. gage.....	.....	225	495	685
Power available from steam expanded to 15-lb. gage.....	2,005	2,630	3,240	3,790
Power available from steam expanded to 28-in. vacuum.....	2,995	2,145	1,265	525
Total power, kilowatts.....	5,000	5,000	5,000	5,000
Boiler Installation‡				
Total boiler installation, sq.ft. of heating surface.....	33,400	29,000	25,600	23,400
Size of each boiler, sq.ft. of heating surface	8,350	7,250	6,400	5,850

* This table is based on 75 per cent Rankine cycle efficiency ratio of turbine generating unit.

‡ The boiler installation consists of four boilers, three of which are operated at approximately 170 per cent rating and the fourth one is a spare unit.

Boiler-Plant Equipment

Table II is arranged to show the costs of each different plant and also the subdivision of costs of the major items. These figures should not be considered as exact values, as they are subject to too many market variations and local conditions. The costs are mostly based on actual quotations within the last year, and where no quotations were available the costs are based on current market conditions. Erection charges are included, but freight, being a very variable item, has not been taken into account. It may, however, be considered as taken care of in the 15 per cent allowance for contingencies. The location is assumed to be in the eastern part of the United States.

The buildings are of ordinary mill-type brick construction and have incorporated in their design the necessary structural arrangements for coal and ash handling.

Each boiler plant consists of four water-tube boilers, their sizes being as given in Table I. They are equipped with superheaters of the proper size to give the temperatures indicated in the same table. The economizers are so designed that their surface is in each case equal to 50 per cent of the respective boiler surface. Three of the boilers are assumed to be operated at approximately 170 per cent rating and the fourth is a spare unit.

Underfeed stokers are used, having eight retorts per boiler for the 150-lb. plant, seven retorts per boiler for the 250-lb. plant and six retorts per boiler for the two other plants. The proper prime movers for driving the stokers are also included in the cost.

All auxiliary machinery is so proportioned that sufficient spare capacity is available for taking care of overloads and breakdown service.

Type of Feed-Water Heaters

Open feed-water heaters only are included, although the high-pressure plants in particular would probably make use of stage heating. Enough steam is assumed to be available from process steam and steam-driven auxiliary machinery to heat the feed water to 212 deg. F. No allowance has been made for auxiliary drive in the cost of power, but the difference between high- and low-pressure conditions would in any case only be on the order of $\frac{1}{2}$ per cent or less.

Where the cost of a certain piece of apparatus is not influenced by the pressure, the cost at 150-lb. gage has been used as a base price and has been prorated by means of curves for the higher-pressure plants. Where the cost is a more or less direct function of the pressure, actual quotations have been used, except for piping and instruments which have been assumed to be about 10 per cent of the total initial cost. This procedure may be open to argument, but in view of the indeterminate nature of these items, which are to a certain extent subject both to personal opinions and to local conditions, it seems the rational way to obtain consistent results.

In order to allow for engineering and contractor's profit, 10 per cent has been added to the total cost and in addition 15 per cent has been allowed for contingencies, etc., making a total of 25 per cent as given in Table II.

The last part of Table II gives the annual operating cost for each boiler plant. The fixed charges include interest, depreciation, taxes and liability and fire insurance, and amount to 15 per cent of the total investment.

TABLE II—COST DISTRIBUTION IN BOILER PLANT

Steam conditions	150 Lb. Dry and Saturated	250 Lb. 75 Deg. F.	400 Lb. 100 Deg. F.	600 Lb. 125 Deg. F.
Initial Cost				
Buildings including real estate.....	$60,000	$53,000	$48,000	$44,000
Boilers, superheaters, economizers and foundation.....	140,850	143,150	130,100	179,100
Stokers.....	40,000	35,000	30,000	30,000
Fans and ducts, etc.....	26,950	23,500	20,700	18,950
Piping and instruments.....	71,500	69,000	65,000	73,000
Feedwater heater and pumps.....	8,900	8,900	12,050	13,300
Coal and ash handling.....	7,500	6,500	5,750	5,250
Chimney and flues.....	19,000	17,000	15,500	15,000
Total.....	$373,700	$356,050	$327,100	$378,600
Total plus 25 per cent.....	$468,000	$445,000	$409,000	$473,000
Annual Operating Cost				
Annual fixed charges at 15 per cent.....	$70,200	$66,800	$61,300	$71,000
Maintenance at 5 per cent.....	23,400	22,300	20,500	23,700
Coal at $5 per short ton and 13,500 b.t.u..	271,000	237,000	217,250	202,750
Labor.....	30,000	30,000	30,000	30,000
Boiler room annual operating cost....	$394,600	$356,100	$329,050	$327,450

An allowance of 5 per cent has been included to take care of the maintenance cost, and this will probably be close enough for average conditions.

No allowance has been made for water-treating appliances although they are considered necessary in most high-pressure plants. Their cost would, in most cases, be a small percentage, which would have a negligible effect on the total cost. The present-day tendency is to employ water purification in all plants regardless of pressure, and the comparative values should therefore not be influenced.

Prime Movers Required

Each plant requires a different arrangement of prime movers, which will be briefly described. The 150-lb. plant will use two 2,500-kw. turbine generators equipped

for automatic bleeding of the low-pressure process steam, the high-pressure process steam being obtained directly from the boilers through a reducing valve.

A different arrangement is required when higher steam pressures are used, as both high-pressure and low-pressure process steam will be extracted from the main units. Various arrangements and combinations

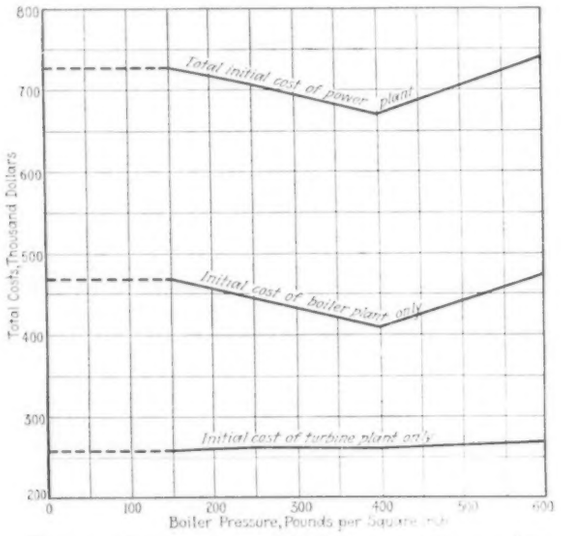

Fig. 2—Curves show initial costs of plants for different pressures

may be employed, but in general one or other of the following will be used:

1. Double bleeder-type turbine, where provision is made for the automatic bleeding of high- and low-pressure steam from the same unit.

2. A combination of a high-back-pressure unit which supplies all the high-pressure process steam and a single-bleeder unit for low-pressure process steam, both of which operate on high-pressure steam.

3. A combination of a high-back-pressure unit, exhausting into a steam main which supplies the high-pressure process steam and also a low-pressure single-bleeder unit, which in turn supplies the low-pressure process steam.

These three schemes are all applicable to industrial power plants, but No. 3 has certain characteristics that make it more desirable, particularly for a plant that contemplates a gradual change from low-pressure to high-pressure operation. The most important point in its favor is that it confines the use of the high-pressure, high-temperature steam to a small and relatively simple structure.

When it is necessary to increase the size of a power plant, it will often be found advantageous to install high-pressure boilers. The steam generated by these boilers is passed through one or more high-back-pressure units, and the exhaust is led into the existing steam lines, as outlined for No. 3. All boilers and prime movers that are in good condition may thus be retained, and no machinery need be scrapped on account of conversion from low-pressure to high-pressure conditions. As the plant grows and additional capacity is required, it will be a simple matter to add gradually the required number of high-pressure units. There are some stations operating in accordance with this arrangement, and this practice, it is expected, will come into general use.

The use of steam turbines designed for higher steam pressures may require some mention. Units operating at 1,500 lb. pressure and even higher have been built, but have not as yet been in operation long enough to allow any deductions to be made. Favorable reports extending over several years are, however, available for units that are operating at from 500 to 600 lb. The lower half of such a turbine designed for maximum steam conditions of 600-lb. inlet pressure, 750 deg. F. total temperature, 150-lb. back pressure and applicable to industrial plants, is illustrated in Fig. 1. Unusually large glands are required to pack against the high exhaust pressure, as is shown at *A*. Only one wheel is used, making this an extremely simple unit particularly applicable to the kind of service previously referred to.

Single-Wheel Turbine

The opinion is often expressed that a single-wheel unit is inherently inefficient, but this is not necessarily true. When a single-disk turbine is properly designed and the operating conditions are appropriate, it is possible to secure a Rankine cycle efficiency ratio of 80 per cent. This high figure cannot be obtained in a small unit, and it is necessary to have a turbine of 4,000 to 5,000 kw. capacity before it can be reached. A comprehensive explanation of the theoretical side of this question is given in the Transactions of the First World Power Conference, Vol. II, pp. 1528-30 inclusive.[1]

As mentioned in the beginning, considerable attention should be devoted to the question of condensing equipment. Generally speaking, with an increase in initial steam conditions, the size of condenser required will de-

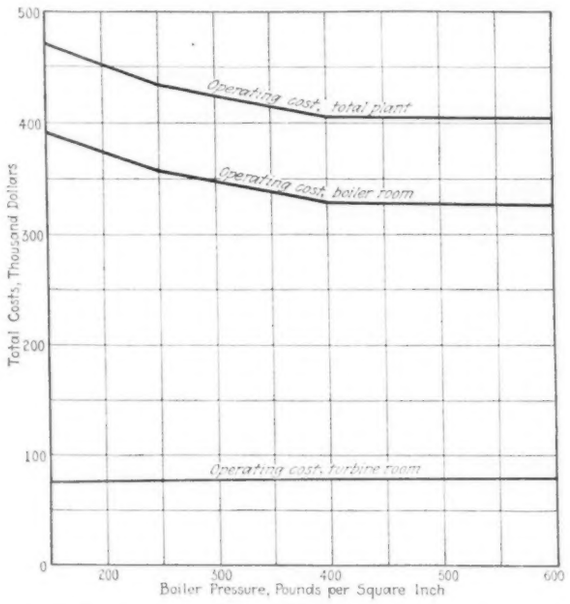

Fig. 3—Curves show operating costs for plants designed for different pressures

crease. This is particularly true when steam is extracted from the main unit, the limiting case being when all the power is obtained from process steam, as, theoretically speaking, no condenser would be required. Unfortunately, however, this is not possible because a certain amount of condensing capacity is required to provide for fluctuations between power and steam demands. Its size is therefore a function of the frequency and

[1] "Steam Turbines and Condensing Equipment," by Francis Hodgkinson, chief engineer, South Philadelphia Works, Westinghouse Electric & Manufacturing Company.

magnitude of fluctuations and interruptions, and for the present purpose it has been assumed that a condenser capable of producing a vacuum of 28 in. with 70 deg. cooling water when passing 50 per cent of the steam required for straight condensing operation, will be sufficient. If this condenser was required to serve the turbine unit at full condensing capacity, the amount of circulating water could be increased and the reduction in vacuum would not be more than about 1½ in., which would not be serious for a short period of time.

The total cost of the respective prime-mover installation is given in Table III, and is in all cases based on using two units for each plant, thus placing them all on a comparable basis. Most of the items that make up this table are not influenced by the pressure, so the variations in cost are consequently small. The same percentages used in preparing Table II have also been used for this table.

TABLE III—COST DISTRIBUTION IN GENERATING ROOM AND TOTAL ANNUAL OPERATING COST

Steam conditions	150 Lb. Dry and Saturated	250 Lb. 75 Deg. F.	400 Lb. 100 Deg. F.	600 Lb. 125 Deg. F
Initial Cost				
Buildings	$35,000	$35,000	$35,000	$35,000
Turbine generators (two 2,500 kw.) condenser and foundations	116,750	119,450	118,550	123,450
Switchboard and transformers	30,000	30,000	30,000	30,000
Wiring	20,000	20,000	20,000	20,000
Railroad siding	5,000	5,000	5,000	5,000
Total cost	$206,750	$209,450	$208,550	$213,450
Total plus 25 per cent	$258,000	$262,000	$261,000	$267,000
Annual Operating Cost				
Annual fixed charges at 15 per cent	$33,700	$39,300	$39,200	$40,000
Maintenance at 5 per cent	12,900	13,100	13,050	13,350
Labor (includes supervision and maintenance)	25,000	25,000	25,000	25,000
Generator-room annual operating cost	$76,600	$77,400	$77,250	$78,350
Total Annual Operating Cost				
Boiler-room annual cost	394,600	356,100	329,050	327,450
Generating-room annual cost	76,600	77,400	77,250	78,350
Annual total cost of operation	$471,200	$433,500	$406,300	$405,800

The last part of Table III shows the total annual cost of steam and power generation, and some interesting conclusions may be drawn therefrom. It is seen that the annual cost decreases steadily up to 400 lb. pressure, but from 400 to 600 there is no appreciable difference. For a plant such as that investigated in this article, the 400-lb. installation would seem to be the one to be employed, as there is no reason for increasing the boiler pressure unless a material reduction in the total cost of operation is to be secured. An increase in pressure would be justified only if more power were required, as it would then be possible to obtain more power without increasing the condensing equipment.

Change in Cost Relative to Pressure

In order to indicate more clearly the change in initial cost relative to pressure, the curves shown in Fig. 2 have been plotted from the total values given in Tables II and III. Strictly speaking, these curves should not be continuous lines, but for purposes of illustration it will be sufficient to use the curves as drawn. It is found that for this particular case the total cost of the boiler installation decreases approximately in accordance with a straight line up to 400 lb. pressure. At this point, however, the limit for standard design boilers is approached, and the field of special design is reached somewhere between 450 and 500 lb. The total cost of the 600-lb. installation is higher than any of the lower-pressure plants in spite of the fact that this is the smallest boiler installation. No actual cost figures are available above 600 lb., but it is fairly safe to assume that if a curve were obtainable showing the total plant cost in conjunction with higher-pressure boilers, it would have a slope similar to the one used with standard boilers. The slope of this line would probably not be quite as pronounced as that shown in Fig. 2.

The total annual operating costs have been plotted for each different plant as shown in Fig. 3. These curves show clearly the improvement that it is possible to realize when increased steam pressures are used. A great number of improvements and refinements can, of course, be applied which would reduce the fuel costs materially, but no attention has been paid to them in this article, as its purpose is to compare the difference in cost rather than actual values. As higher pressures come into more general use, it is expected that the limit for standard equipment will be raised and consequently the initial cost lowered, thus tending to increase the field of higher pressures.

Distribution of Belt Creep and Slip

EXPERIMENTS conducted for the Leather Belting Exchange Foundation, at Cornell University, to determine the distribution of belt creep and slip around a pulley, were described by R. F. Jones in a paper at the recent annual meeting of the American Society of Mechanical Engineers.

In the past, experimenters have attempted to determine this by direct measurement of the belt speed around the pulley, but the results have been unsatisfactory, since this speed is only slightly slower than the pulley speed. If this small difference, the speed of the belt relative to the pulley, could be measured directly, more reliable data should result.

The stroboscopic slip-meter permits this direct measurement. Briefly, this meter consists of a disk mounted on the pulley, with equally spaced oblong holes punched around its periphery. A portable wheel is provided which runs on the belt and has similar oblong holes, so spaced that each time a hole in the disk comes opposite the wheel, there is, as closely as possible, a corresponding hole in the wheel in alignment when both the wheel and the disk are running with the same peripheral speed, except for the slight correction due to belt thickness. If a light is placed in back of the wheel and disk, this condition of balance is evidenced by a lighter aperture, apparently stationary. When the belt is slipping on the pulley at the point the wheel is in contact with the belt, the peripheral speed of the wheel is less than that of the pulley and the holes no longer align continuously. This is evidenced by a slow revolution of the lighted aperture, and the slip may be calculated from the time required for this aperture to make one revolution.

As a result of this investigation it was determined that the belt creep extends from the last point of contact backward through an arc that increases with the load. Slip begins when this arc becomes equal to the arc of contact. This condition limits the capacity of the belt unless the coefficient of friction increases with the slip, as in the case of leather, when much higher loads can be carried without extreme slip.

If a small pulley is used with a larger one, this true slip begins first on the small pulley and the greater part of the total slip will take place on this pulley.

Automatic Coal Sampler at Springdale Station

By T. Thorsten
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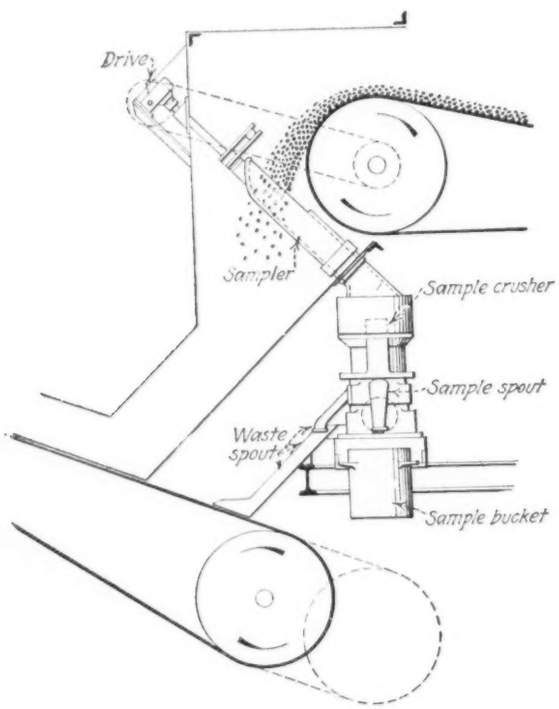
THE earliest method used to obtain coal samples was to take occasionally a shovelful from the coal-handling apparatus and quarter it down to a convenient amount for pulverizing for analysis in the laboratory. Where flight conveyors are used, the automatic opening of a gate in the bottom of the coal-carrying trough gives a good but too large sample. With bucket elevators an occasional removal of part of one bucket's contents gives a satisfactory result, but to do this automatically and correctly is difficult.

To obtain a sample from a belt conveyor, the most common method is to have a swinging spoon which automatically secures a sample by dipping into the stream of coal, but it was found at the Springdale Station of the West Penn Power Co. that the samples obtained were not correct.



The opening in the sampling tube is such as to take in the full depth of the coal stream

Coal on the belt conveyor might be well mixed at the loading point, but as it travels to its destination, the finer particles work to the bottom and the larger particles to the top. The coal receives not only motion due to the belt's being bent over the carrying idlers, but because of the troughing of the belt at the idlers and flattening between the idlers, it gets a sideways motion which aggravates the separation of the finer and larger coal.

When a swinging spoon sampler or any similar device is used, the spoon, in dipping into the coal stream, will be filled with the outer layer, which is the coarse coal, before it reaches into the finer strata. The result is not a true sample.

In studying the different methods of obtaining samples automatically, a new idea was worked out which has proved satisfactory after one year's trial at Springdale. Its application is shown in the illustration.

Approximately 90 deg. to the coal stream leaving the head pulley of the belt conveyor to the power station and near its longitudinal center line is installed an automatic sampler. This consists of a tube provided with an opening in one side of sufficient length to take in the full depth of the coal stream and of sufficient width to receive the largest pieces of coal. This tube or sampler revolves at a slow speed (in the case of the Springdale installation at one revolution every three minutes) and is driven from the belt pulley through a belt and reduction gears. It is supported at the lower end on a roller bearing and at the upper end on a ball bearing.

When the sampler is at the point of exposing its opening to the coal stream, a quick revolving movement is imparted to it, exposing the opening for a short interval and obtaining a sample corresponding to the speed of the falling coal and the time the opening is exposed. The sample obtained is conveyed through the hollow tube to the crusher. Five per cent or less of the sample is retained, and the surplus is discharged to another conveyor.

As the opening in the tube is vertical to the coal stream, the sample contains both the coarser coal on top and the finer particles on the bottom, thus giving a true sample. The size of each sample varies with the amount of coal on the belt, but the average is about ten pounds. The daily sample, resulting from the individual samples, is quartered and two quarts of coal retained. One quart is used for determining the moisture content and the other is pulverized for chemical analysis. As a matter of interest it might be stated that the ash content will sometimes vary from day to day from 8 to 16 per cent, although the coal comes from the power company's own mine and an effort is made to produce the best and most uniform coal.

During its one year's operation at Springdale, this automatic sampler has worked entirely satisfactorily, and as the driving mechanism is running in oil and the sampler is of heavy cast iron, practically no wear has taken place and no attention is necessary, as it starts and stops with the belt conveyor.

Where a very wide conveyor belt is used or where the loading of coal on the belt is such that different grades of coal might be placed unevenly over the surface, it might be necessary to install a reciprocating type of rotating sampler. This would obtain a sample at predetermined intervals at different locations over the width of the belt.

Such a sampler may also be used in connection with coal elevators and installed in the chute from the elevator at approximately 90 deg. to the coal stream.

Progress in Steam Tables Research as carried on jointly at the Bureau of Standards, Harvard University, and Massachusetts Institute of Technology is going steadily forward; obstacles are being overcome; and some observations along the saturation boundaries are completed. There seems to be good ground for hoping that within another year a large body of observations will be in hand. Precise work of this nature costs heavily, and proposals have been made for securing additional financial support for this research.

Boiler Plant Runs Automatically at Masurel Worsted Mills

By C. J. AUCLAIR
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SINCE it first went into operation in October, 1925, over eight hundred visitors have inspected the automatic boiler plant at the works of the Masurel Worsted Mills, Inc., in Woonsocket, Rhode Island. The attraction lies not in the size of the plant, which is small, but in its novel design. Every feature of regular operation is automatic. In short, the plant normally runs itself, the engineer's duties being confined to general supervision, repairs and occasional adjustments. This is accomplished by the liberal application of automatic devices covering every phase of control.

When the steam pressure rises to a certain predetermined point, the oil burners automatically shut down. They also shut down in a few seconds if the flame is accidentally extinguished. Feed water is automatically controlled, as is the makeup to the open heater. Recording instruments keep a constant check on efficiency of operation, the result being a remarkably high economy maintained day in and day out.

EVERYTHING is automatic in the recently completed boiler plant of the Masurel Worsted Mills, Inc., Woonsocket, R. I. Oil burners are switched on and off by the steam pressure, a special safety device shutting down the burners at once if the flame is extinguished. The feed-water system is likewise equipped to operate without manual control. The plant is equipped with feed-water meters, oil meters, recording pressure gages and flue-gas pyrometer, and a CO_2 recorder. Steam is generated at a total cost of 65 cents per thousand pounds, including all direct and overhead charges. The actual evaporation averages 13.82 lb. of water per pound of 19,500 B.t.u. oil.

It was in February, 1925, that we decided upon building a steam power plant which was undoubtedly necessary for the operation of our worsted yarn mill. From that time until the latter part of July we visited 53 steam power plants in order to study the best modern methods and equipment. However, to our great disappointment we found that very few operators were in a position to give us any tangible information regarding the cost of their steam per thousand pounds, owing to the lack of a complete installation so equipped as to determine the cost. In many cases we did not care to humiliate the operators with questions pertaining to combustion, as they did not even know the constituents of their oil or coal.

We were therefore thrown largely on our own resources in fulfilling our ambition to build the best possible plant. The results, as will be shown, have justified our fondest hopes.

The small size of the plant made completely automatic operation highly desirable as a means of keeping down labor costs and at the same time maintaining the highest possible operating efficiency. Oil was the only fuel that could be considered for automatic operation. It was the writer's opinion, since proved correct by the operating records, that oil would also show a lower fuel cost than coal because of the higher combustion efficiency obtainable. The matter of a suitable burner was given close study, the final selection being an automatic motor-driven mechanical burner. The burner selected was installed on a six-months' trial basis and proved highly satisfactory.

These burners were installed in special combustion chambers, one under each boiler. There are two boilers of the horizontal return-tubular type, each having 1,040 sq.ft. of heating surface. Each boiler has 76 3-in. tubes 16 ft. long. The boilers are connected on top through 6-in. non-return angle valves, 90-deg. bends and 6-in. gate valves to a 10-in. welded header. A 4-in. line runs from this header through an underground tunnel to a standard reducing valve, size 4x6 in., which reduces the pressure from 90 lb. to 8 lb. for the heating and hot-water systems. These consist of 14,000 sq.ft. of radiation plus mains, risers and hot-water heaters having a total capacity of 120 gal. per hour.

We also take a tap on the 4-in. high-pressure main with a 2-in. high-pressure line that feeds five vaporizing rooms of 900 cu.ft. each. While each of these rooms consumes about 2,000 lb. of steam per hour at 90 lb. pressure, they are never operated all at once and, therefore, do not overload our boilers.

The heating system is of the vacuum-return type, using vacuum traps. All condensation is returned to a strainer, where the water temperature is generally 110 deg. F. At this point a 6x8x12-in. vacuum pump, controlled by a regulator, maintains a constant vacuum of 15 in. From this pump the condensation is delivered to an air-separator tank. The water is then released to an open-type feed-water heater, the flow being controlled by a float valve to suit the load on the boilers.

The heater is so arranged that at the low-water line a secondary float valve is opened to allow the city water service to supply makeup water. The heater is heated by the exhaust of the vacuum and feed-water pumps only, and is equipped with oil separator, oil drain, safety valve, vacuum-release valve, main drain, and indicating thermometer. The surplus steam in the heater is exhausted to the heating main, first passing through two oil heaters of 60 gal. capacity each. This system of heating the oil has proved very efficient as it permits a better vaporization of the oil and avoids all waste of steam. The water in the heater is generally warmed

to 180 deg. F., which is a gain of 70 deg. over the vacuum return. Thermometers are installed in various parts of the system. These tell at a glance what is going on.

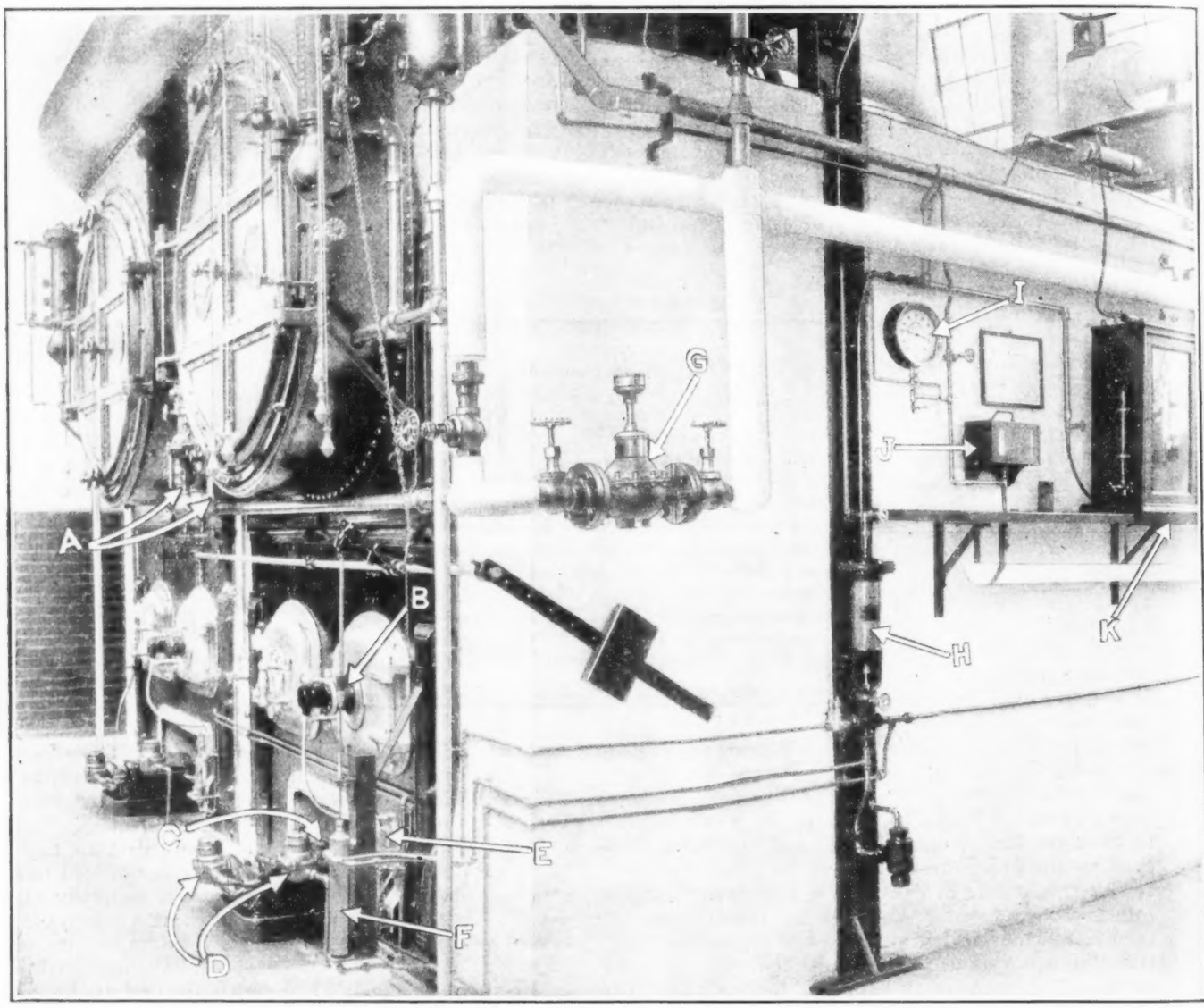
The water in the heater is pumped to the boilers by a duplex feed pump controlled by a pump regulator which, in turn, is actuated by the feed-water regulators. Each pump is equipped with a bypass for emergency. An injector also is installed for emergency use.

All water fed to boilers is measured by a meter of the disk type and readings are taken every day. The boilers are equipped with a pressure control that shuts off the oil burners when the pressure reaches 90 lb. and also closes all the dampers tight. This permits the boiler to generate steam, even while the burners are not operating, owing to the heat in the refractories. The pressure is allowed to drop to 84 lb., after which the dampers open automatically, followed shortly by the starting up of the burners. This cycle of operation is governed by the demand for steam.

In several cases we have noted, particularly when the burners had been operating a long time without any stops, and the refractories were incandescently hot, that the burners did not have to operate for periods of from 20 to 30 minutes, and during all this time the boilers were supplying steam to meet a demand of 2,000 lb. per hour.

The burner control is governed from the steam pressure by a steam piston that actuates a water piston valve. The water is allowed to pass to a main piston which operates all the dampers in the breeching and also to sub-pistons which open or close the series switches that control the motors on the automatic oil burners.

One burner is installed under each boiler in a special combustion chamber. These burners are equipped with gas pilots, flame safeties, trip buckets, electric oil-control valves, oil meters, strainers, adjustable needle valves, and electric automatic relay controllers. Two gas pilots are installed in each burner, operating with high flame



Panoramic view of automatic boiler plant. A—Diaphragm valves on feed lines; B—Flame safety; C—Oil burner; Steam-pressure recorders; K—CO_2 recorder; L—Flue-gas pyrometer; M—Feed-pump regulator; N—Injector;

for several seconds before the burner starts and with low flame for several seconds after the burners are in full operation. This installation operates safely and without waste.

The flame safety is installed on one of the inspection doors, the existence of a flame in the combustion chamber forcing a diaphragm to expand and thereby closing two contacts. These close relays which permit the motors to operate.

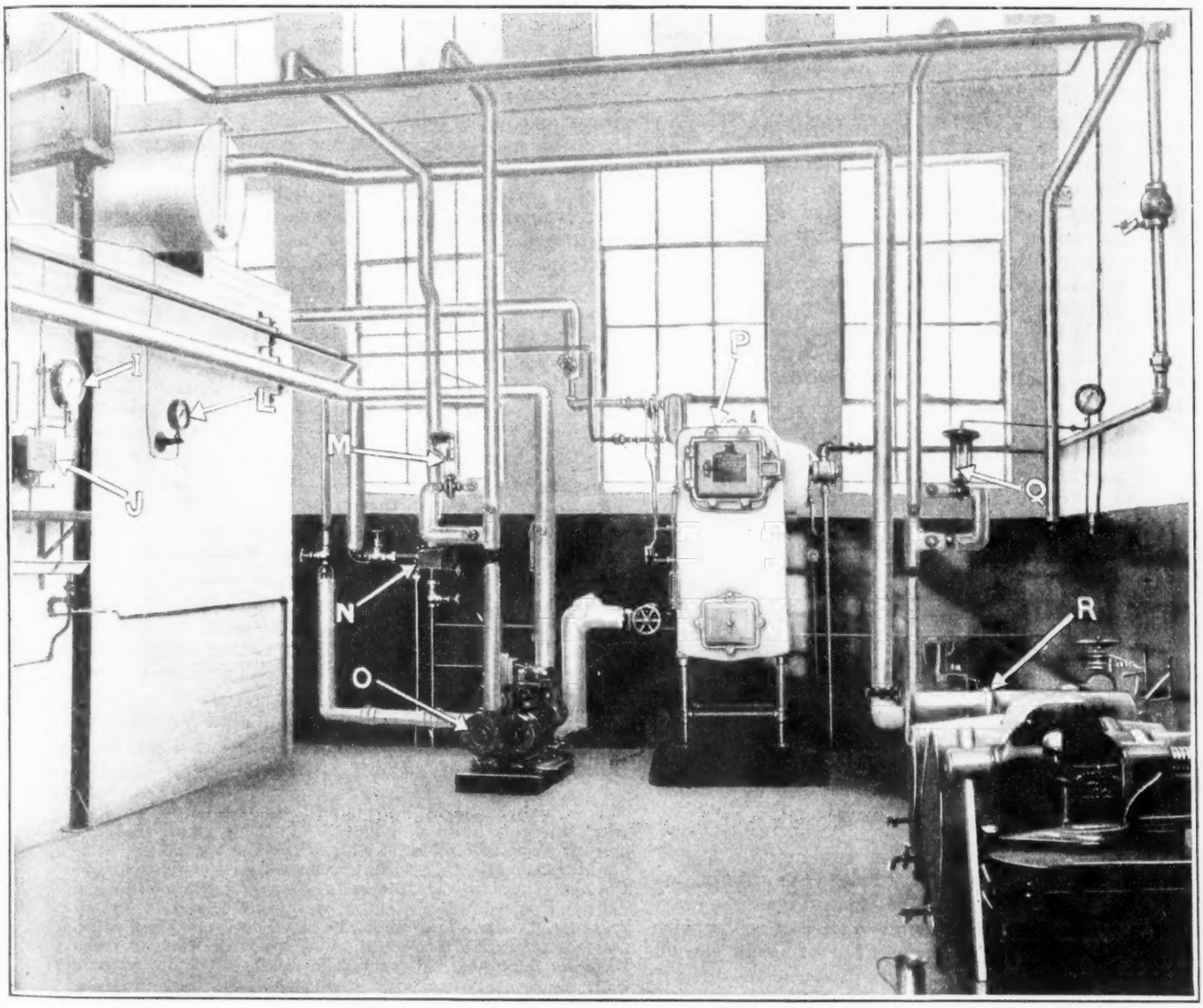
Should the flame be extinguished for any reason whatever, the contacts in the flame safety open, thus breaking the relay circuit and allowing the motor to operate through a time-set resistance which trips and breaks the motor circuit and lights up a red signal lamp, giving warning that something is wrong. The time required for tripping can be adjusted from 6 to 30 seconds. The trip resistance is manually reset, after making an inspection and rectifying the cause of the trouble.

The burners are of the mechanical-draft type controlled by ¼-hp. motors, 1,800 r.p.m., 110 volts, single-phase, 60 cycles. A special gearing permits the turbine and spray plate to revolve at a speed of 1,300 r.p.m. An air damper in the air passage can be adjusted for any amount of air required.

A direct-connected pump attached to one end of the motor through a flexible coupling, pumps the oil (28-32 deg. Baumé) from a 16,000-gal. tank through the oil heaters, siphon breaker, strainer and oil meter. It then enters the pump and is forced through a delivering chamber fitted with two needle valves, for adjustment of the amount of oil desired to be burned. At this point a pressure of 12 lb. exists. This is reduced by the needle valves, which allow a pressure of 1 lb. only to pass through the electrically operated valve to be delivered at a special nozzle on top of the spray plate.

The valve just mentioned is opened only while motor is electrified, and thus does not permit any oil to pass through the valve after the motor circuit is broken, with the motor and pump still in motion.

We are burning at present about 35 gal. of oil per



D—Oil meters; E—Relay; F—Control cylinder; G—Feed-water meter; H—Pressure control; I—Steam gages; J—O—Feed pump; P—Open heater; Q—Vacuum-pump regulator; R—Vacuum pump (behind oil barrel)

hour per burner. This amount is adjusted to our steam demand. We burned last winter, on certain occasions when we forced one of our boilers, as high as 55 gal. per hour per burner.

The fuel oil that we use burns very clean, thanks to the perfect vaporization of the oil by our burners, so we are not annoyed by carbon or soot. Every three months we shift boilers and clean the one last in operation internally and externally. With the aid of good makeup water and boiler compound we are not annoyed with rust or pitting.

Using the data furnished daily by the disk-type feedwater meter and the oil meters at the inlet and outlet of each burner, our average evaporation today is computed as 13.82 lb. of water per pound of oil.

CO_2 Instrument Helpful in Adjusting Air and Oil

As already noted, each boiler is equipped with indicating and recording pressure gages. Our CO_2 recording instrument has proved of great value for adjustment of air and oil for good combustion, the average CO_2 obtained lying between 12.5 and 14.5 per cent.

The indicating pyrometer has never shown a flue temperature any higher than 176 deg. C., which is equivalent to 349 deg. F. This indication exists only when both boilers are in operation; with one boiler operating the reading is generally 168 deg. C., or 334 deg. F. The CO_2 recorder and pyrometer are tested each month.

At the price we are now paying for oil (of 28-32 gravity and 19,500 B.t.u. per lb., with less than ½ per cent sulphur content), we are generating steam at a cost of 65c. per thousand pounds. This cost covers the oil, gas, electricity, depreciation, insurance, overhead, and all other items that come under industrial control. We expect to cut this cost shortly, as we are considering burning an oil of 20 gravity in winter and 16 gravity in summer. This fuel will not necessitate any new apparatus, heaters or changes whatever, as the 20 gravity oil will not congeal at 0 deg. F., and our burner pump is fully capable of handling it. Last winter we had the pleasure of burning some of this oil under severe conditions, and it proved satisfactory in combustion and evaporation results.

Estimates $3,500 Saved Yearly

We estimate that this automatic system saves $3,500 yearly that we would otherwise have to pay for maintenance, plus all the other advantages that we have over ordinary oil or coal-burning plants. Of course, our results are the accomplishment of a complete set of automatic apparatus which works in synchronism in a most harmonious way.

We are convinced from our experience that steam can be generated by oil at a cost as low as, if not lower than, by coal, when intelligently installed with the proper equipment. One must remember that the cost of oil pound for pound is offset by the greater amount of heat, higher combustion efficiency and the abolished cost of maintenance in the case of an automatic plant.

During these ten months of operation we have maintained various loads for long periods, the amounts ranging from 5,000 to 1,000 lb. of steam per hour, and yet we have never experienced an evaporation of less than 12.5 lb. of water per pound of oil. The maximum reached for several days in a stretch was 15.5 lb. These figures are the actual evaporation.

Damages Awarded Workman Injured When Crane Man Misunderstands Signal

In the recent case of Daggett vs. American Car & Foundry Co., 284 S. W. 855, the Court of Appeals of St. Louis, Missouri, held that a workman whose duty is to signal to start a crane, is not a "fellow-workman" of the crew employed to operate the crane and perform labor thereabout.

The facts of this case are that a man by the name of Daggett was employed by the American Car & Foundry Co. and was put under the control of a foreman. Later the foreman changed the man Daggett from the previously assigned work to go over and help the crane men move the material over to a punching press and to do whatever they asked him to do. The crew of men working at the crane consisted of an operator who was stationed in the crane cab and operated it according to orders and signals, and two chain men who worked on the ground, attaching and detaching the material to and from the cables. One of these chain men was the leader who always gave the orders and signals to the operator of the crane. The signals were given by signs consisting of raising the hand to indicate the desire to hoist the material, and lowering the hand to lower the material.

While the man Daggett was placing a chain around one end of a number of iron bars to be moved, he was ordered by the person in charge of the crane crew to slip the chain farther toward the center of the bundle. The operator of the crane understood that the material was to be hoisted and thereupon started the crane. As a result Daggett was severely injured.

The counsel for the defense argued that the foundry was not liable for the injuries sustained by the workman, on the grounds that the leader of the crane crew was a fellow employee of the injured man, under which circumstances the law is well established that an employer is not liable for injuries effected one employee by another fellow workman.

In holding that the foundry was liable for the damages to the extent of $3,000 for the injuries sustained by the workman, the Court said:

> This man assigned the plaintiff to certain duties, and, when the chain, which plaintiff had fastened around one end of the bundle of bars, slipped too far toward the middle of the bundle, this chain man motioned for him to move the chain back toward the end. He was the one who had his hand raised when plaintiff was injured, and it was in response to his signal that the material was lowered so that the plaintiff's foot could be released. In view of these facts we think that this case falls squarely within the rule that, where a servant is given authority to direct and control other servants in a branch of the master's business, he is not a fellow servant with the others, but is a vice principal for whose negligent act the master must respond.

The Volume of Electrolyte in a storage battery cell, and therefore its specific gravity, varies with the temperature, the volume increasing and the specific gravity decreasing with a rise in temperature and vice versa. When determining the true value of specific gravity readings taken with a plain hydrometer, temperature corrections must be made by adding 0.001 to the readings for each 3 deg. F. above 70 deg. and by subtracting 0.001 from the readings for each 3 deg. below 70.

Extinguishing Fires in Hydro Generator Windings

By J. ELMER HOUSLEY

A SYSTEM of spraying water on the windings, in case of fire in the machine, has been installed in a number of units. For one fire alone this saved many times the installation cost of the protection.

LARGE vertical generators, such as will be found in many hydro-electric plants, are relatively slow-speed machines of large physical dimensions and require a great volume of air for ventilating purposes. These construction features render the winding vulnerable to destruction by fire and impose difficulties in extinguishing fire after it once starts. These generators are usually provided with molded mica insulation on the portion of winding that rests in the slots of the core and with varnished cambric and linen tape, varnished between turns, on the exposed end portion of the winding. The voltage is ordinarily limited to 13,200 volts or lower because of the inherent troubles due to corona destroying the insulation when operating above this voltage and the difficulty of building up insulation on the coils without air voids, which is the chief source of trouble and keeping the insulation within the space limitations existing. Recently, generator voltages of 16,500 and 18,000 volts have been announced; these are, however, on steam-turbine units.

Oil Throwing from Bearing Housings

Vertical units are susceptible to oil throwing from the bearing housings, and extreme care is necessary to guard against this condition, which imposes a further hazard of inflammability. The most serious thing with regard to these generators is the fact that the most trivial arc or fire in the generator may be instantly whirled around the stator by the rotor and as a result the entire winding destroyed, with large monetary losses and, worse, the production loss for one to three months.

Various methods have been devised to prevent the spread of the fire, such as the use of radial deflecting devices in the air-current path and water-spray systems to drench the coil ends after the field current has been cut off the machines. In one plant having a number of large generators, using induced-draft 40,000-cu.ft.-min. fans to assist the ventilating fans on the rotor, a water-spray system for extinguishing generator fires was installed after a fire destroyed one winding. The extinguishers have been in service about three years and one fire has occurred since they were installed, due to insulation failure between phase-coil leads, with the loss of only one-seventh of the winding and an interruption of ten days including time required to dry out the remainder of the winding, which had been drenched with water. The old coils were heated by direct current while the new coils were being installed. The saving in this one case, it is estimated, would buy fire-extinguishing equipment for fifteen generators without counting any production loss whatever.

This rather simple system is found in a number of hydro plants and is furnished usually by the generator maker. There are four half-circles of 2½-in. spray pipes, two placed just above the upper coil ends and two below the lower coil ends, as in Fig. 1. These pipes are attached to the removable cast-iron solid frame or bell over the ends of the winding. Small U-bolts are put over the pipe and project through the frames to the outside, and nuts with lock washers hold the pipes in place. There is a removable wire-mesh screen over the remainder of the top of the generator, and easy access to the pipes is provided. Cover plates provide access to the lower pipes from the turbine gate pit just below the generator. The pipes are drilled with a large number of ¼-in. holes on about 7.5-in. centers, arranged to play a series of jets on the coil ends. Two half-circles are supplied by a 3-in. feeder, and these two feeders join in a short 4-in. pipe and are controlled by a 4-in. motor-operated gate valve *A*, Fig. 2, and a hand-operated globe valve, the latter being normally open. A telltale hole is drilled in the pipe just beyond the con-

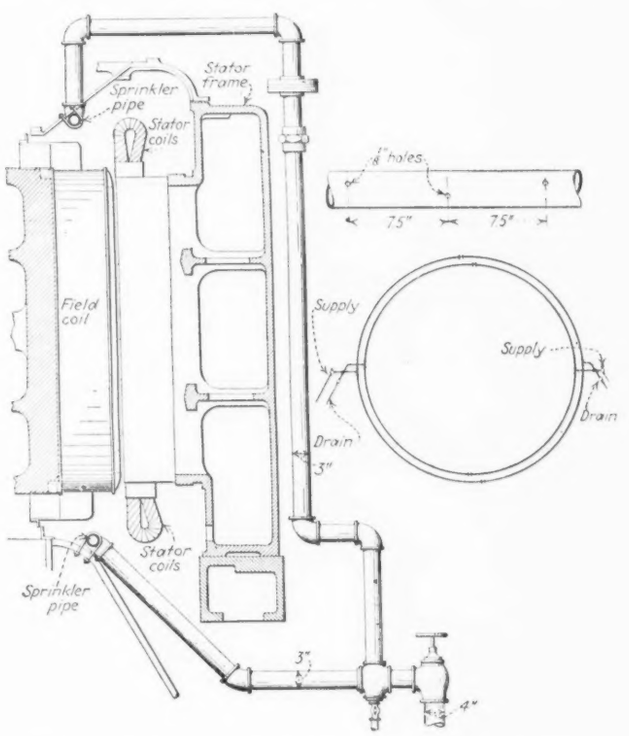


Fig. 1—Section through generator showing location of sprinkler pipe

trol valve in order to detect leakage from the valve. All extinguishers are supplied from a 6-in. water main connecting to each penstock with a valve between the main and the penstock, with the valve normally open. The code of instructions given the plant operators with a brief description of the fire-extinguishing equipment follows:

Description and Instructions

Section I—The fire extinguisher apparatus consists of a circular pipe with spray nozzles mounted above the generator coil ends at the top and below the generator coils at the bottom. A large volume of water can be sprayed on the coils by opening a motor-operated valve at one side of the generator. The valve can be operated electrically by a control switch A, Fig. 3, on the benchboard. A glass cover must be broken before the switch can be operated. The control has two pilot lights; one, green, burns constantly when the valve is shut; the other is red and lights when the valve is fully open to flood the generator with water. The switch has three buttons which make momentary contact. If the top, or "open," is pushed in and then released, the valve will open full and stop automatically. If it is desired to stop the valve at any time while opening or closing, the center button can be pushed in and the motor will stop. From this point the valve can be either opened or closed by pushing the proper button. The lower, or "shut," button can be pushed in momentarily and the valve will close and stop automatically. In case of fire inside of the generator the following operations will be made in the order given:

Section II—In case of fire, where generator is not cleared from line by automatic relays. First, open generator oil

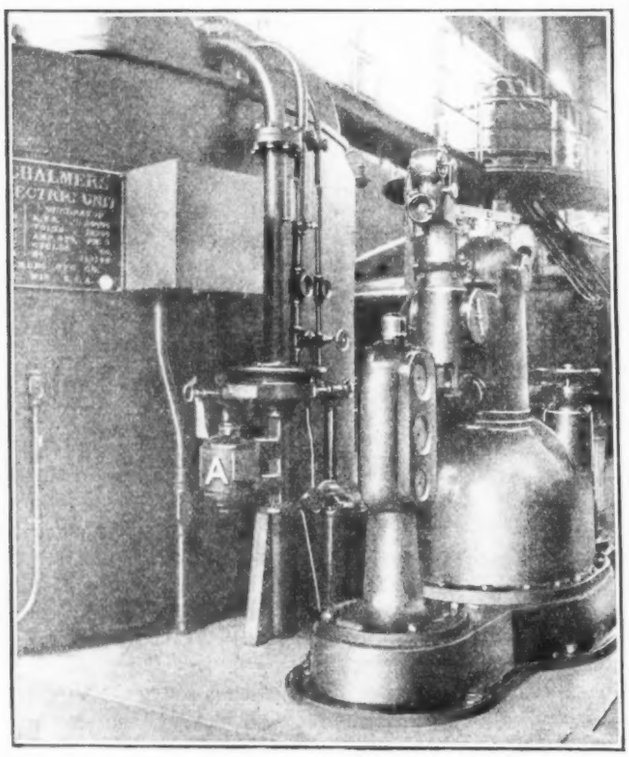


Fig. 2—Motor-operated valve is at A

switch. Second, open generator-field circuit breaker. Third, close turbine gates. Fourth, apply generator air brake. Fifth, break glass over control switch for fire extinguisher valve and push down top of "open" button momentarily and the motor will open the valve wide and stop automatically. When wide open, a red pilot light on control switch lights and the green light normally lighted will go out. Sixth, as soon as floor man sees that fire is out, push down lower, or "shut," button and valve will shut and stop automatically.

Section III—In case of fire where generator is cleared from line by automatic relays and the field switch is also opened by the same relay, begin with third operation and follow through with remainder of operations as given in Section II.

Section IV—Where the operator is not certain that there is a fire in the generator, but where there is evidence of some trouble or smoke, as from a hot bearing or rubbing brake shoe, the generator must be cleared from the line,

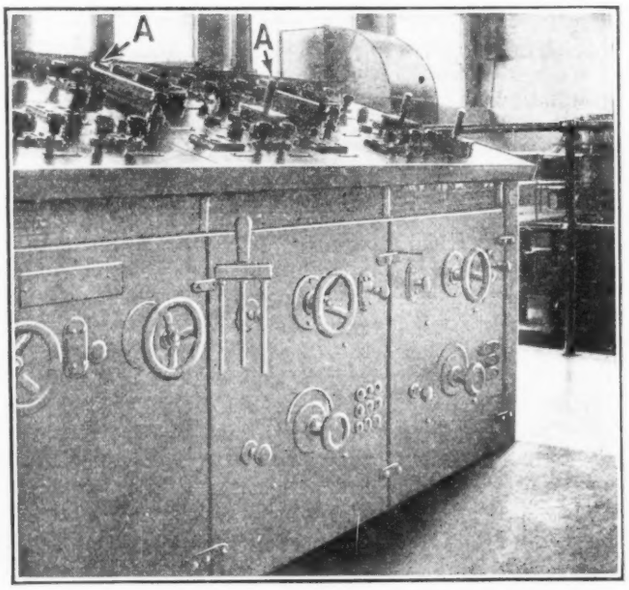


Fig. 3—Motor-operated valves can be controlled from switches located at A

field breaker opened, turbine gates closed and air brake applied, but he must not turn on the fire extinguisher unless the fire is visible or the floor man makes an inspection and finds a blaze in the generator winding. After the operator has made certain there is a fire in the generator, he will open the fire extinguisher valve and close it as instructed in Nos. 5 and 6, Section II.

Section V—In case of fire in the generator and in the remote case that control voltage fails at the same time, the main oil breaker must be tripped by hand first. Second, trip field breaker by hand. Third, close turbine gates. Fourth, apply air brake. Fifth, floor man will pull out brass knob on handwheel of fire extinguisher valve which disconnects the motor drive and will then open the valve by hand. Sixth, after the fire is out the valve must be closed by hand immediately.

The Capacity of Instrument Transformers depends not only on the load on the transformer, but also on the accuracy desired. A potential transformer is usually rated at 200 volt-amperes and compensated for some other rating, such as 50 volt-amperes. This means that the transformer will be most accurate at 50 volt-amperes. At full load the error will be from ½ to 1½ per cent. Current transformers usually have a rating of 50 volt-amperes and are compensated for 25 volt-amperes, but may carry a load of 150 volt-amperes with an error of from 3 to 4 per cent.

A Lagging Power Factor tends to decrease the voltage of an alternating-current generator below what it normally would be at unity power factor for a given kilovolt-ampere load, while a leading power factor will tend to cause the voltage to rise.

Heat Transfer Through Wet Condenser Tubes

By R. H. ANDREWS
Paris Representative of *Power*

THE author here presents some interesting speculations on the nature and rate of heat transfer from steam through wet condenser tubes. It is his conclusion, which he hopes to verify later by experiment, that a dry tube is the most efficient, but that after a film has once formed, a thick film gives better heat transfer than a thin one. He suggests the application of these ideas to condenser design. His thoughts are presented to the readers of *Power*, not as well established theories, but as interesting hypotheses worth thinking about.

HEAT TRANSFER through the walls of condenser tubes flooded by the condensate from tubes located vertically above has been the object of a vast amount of research; for in condenser banks in which the tubes are centered on vertical and horizontal lines, most of the condensing surface is wet and therefore works at a low efficiency. Yet, to the best of the writer's knowledge, little attention has been given to the determination of the zone where the moisture ceases to gather into drops or streamlets and forms a continuous film covering the entire tube surface.

In reality this may be a question of vital interest, for this zone probably marks the point of lowest efficiency in heat transfer of the whole condenser bank. It is usually assumed that, at least within the limits of the surface used mainly for condensation proper as opposed to devaporization, the coefficient of heat transfer decreases from the top to the bottom of the bank, as the thickness of the water film increases. This would be correct if heat were transferred through the film by conduction, but the opposite is probably nearer the truth.

The mechanism of heat transfer in a tube covered with a continuous water film is entirely different from that in a dry tube. The thermal conductivity of water being almost zero, a very small amount of heat travels by conduction, and the bulk of the energy is conveyed by convection currents set up within the thickness of the film, as shown in Fig. 1. As the water flows around the tube, friction against the surface of the metal causes the water particles to revolve between the surface of the metal and that of the film, thus coming alternately in contact with the hot steam and the cool tube walls and conveying heat from one to the other. The motion of the water within the film may be likened to that of a series of rollers traveling around the tube, with the difference that the diameter is not constant, the film being thinner at the ends of the horizontal diameter.[1]

From the practical viewpoint the interesting fact in this process of heat transfer is that, contrary to the natural assumption, the heat-carrying capacity of the water film *increases* with its thickness; so that, were the whole condenser filled with pure steam—that is, with no air present—the rate of heat transfer would be considerably higher in the lower tubes than at some point near the top of the bank, where the water film first becomes continuous over the surface of the tube. A brief analysis of the motion of the water particles will make this point clear.

[1]Geometrically, the path of the water particles probably approaches some form of cycloid, in which the diameter of the generating circle is reduced in accordance with a definite law.

Motive Forces Acting on Water Film

Fig. 2 shows an enlarged cross-section of the tube wall and of the film. The forces acting on the film to produce motion are:

1. The resultant of the gravity forces acting on each water particle applied at the center of the water film;
2. The friction resistance between the liquid and the metal, acting upward and applied at the tube surface.

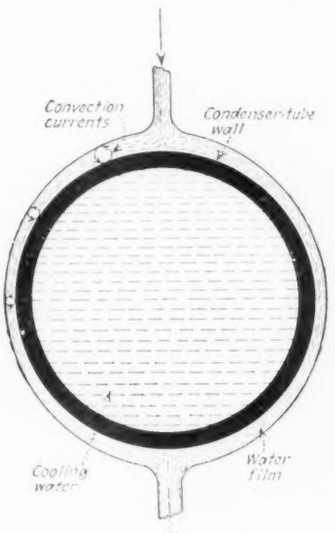


Fig. 1—Tube with film of water, showing convection currents

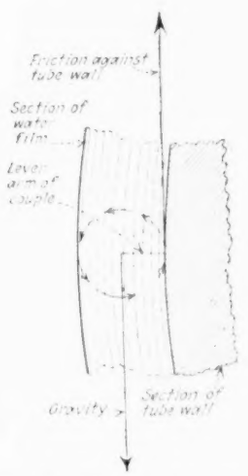


Fig. 2—Enlarged section of film, showing forces assisting convection

These forces form a couple tending to produce the rolling motion described, the lever arm of the couple being equal to one-half the thickness of the film. This couple is balanced by the internal friction forces between water molecules (viscosity) which act as a brake to keep the velocity of the water particles proportional to the motive torque.

The amount of heat that can be carried by moving water in one second—that is, the rate of heat transfer—is proportional to the quantity of water passing per second from the hot to the cold terminal points. It is

therefore proportional to two factors: The weight of water available for the transfer; the average velocity of this water.

The first factor is the total weight of water contained in the film, and therefore varies directly as the thickness of the latter. The average velocity of the water is proportional to the motive torque. The latter is equal to the weight of water in the film multiplied by one-half the thickness of the film. The motive torque therefore varies as the square of the thickness of the film, and the

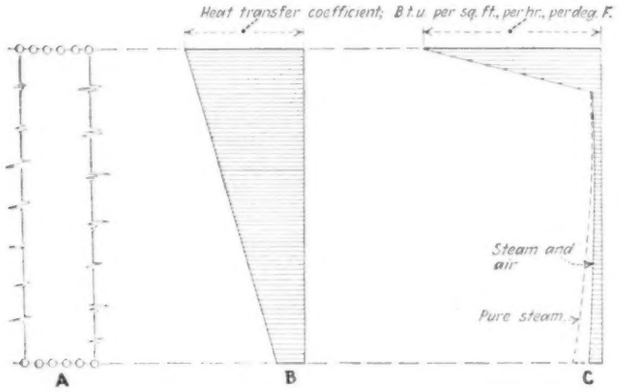


Fig. 3—Variation of heat transfer coefficient from top to bottom of tube bank

B—Common Conception, C—Author's Idea

rate of heat transfer as the cube, provided the condenser is filled with steam free of air.

Considered from another and simpler point of view, the process of heat transfer in a flooded tube may be likened to the process of condensation as a whole, and must be governed, on a smaller scale, by similar laws, for condensation is also a convection problem. The more water that is pumped through the condenser tubes the more heat it can remove. Likewise, the thicker the water film on the condenser tube the more heat it can transfer from steam to metal by means of convection currents.

Variation of Heat-Transfer Coefficient

The object of this discussion is not to advocate greater dependence on the lower tubes, for any gain in the heat-carrying capacity of the water film is offset by the larger proportion of air present in the lower part of the condenser. The aim is rather to emphasize the rapid dropping off in the efficiency of the first few layers of tubes.

Referring to Fig. 3, *A* is supposed to indicate a vertical slice taken out of that portion of a condenser bank used for condensation proper. It is usually assumed that the coefficient of heat transfer decreases gradually from the top tubes to the bottom, approximately after a straight-line law, as indicated at *B*. The truth undoubtedly lies nearer the distribution indicated at *C*, where the dotted line gives the variation of coefficient for pure steam, and the full line for a steam-air mixture such as is found in condenser operation. The coefficient first decreases rapidly to a minimum, at the point where the water film first becomes continuous over the entire tube surface. In an atmosphere of pure steam the coefficient would then increase at a rising rate. With a steam-air mixture this increase may be entirely offset by the insulating effect of the air, and the coefficient may remain constant to the bottom of the condensing bank.

The important points to be retained from the foregoing discussion are:

1. The rapid drop in surface efficiency of the first few layers of tubes in a condenser bank;
2. The existence of a zone of minimum efficiency considerably nearer the front-line tubes than is usually realized.

Position of Zone of Minimum Surface Efficiency

Let us try to form an approximate idea of the position of the zone of minimum efficiency in a condenser bank with respect to the front-line tubes. The problem is to determine at what point the water film becomes continuous over the entire surface of the tubes. A simple experiment will give us a rough approximation. Take a piece of polished brass plate or any other metal, a few square inches in area, and a low-powered microscope—50 diameters is ample. Breathe on the surface of the metal for about 15 seconds, then place it rapidly under the microscope. You will find a large proportion of the surface covered with droplets of moisture. The ratio of wet to dry surface can be estimated as at least 50 per cent, and probably more.

Consider now the rates of condensation that have been measured in the top tubes of a condenser bank. Taking George A. Orrok's figures of 1,000 to 1,200 B.t.u. per sq.ft. per deg. per hour, these tubes would condense roughly 0.5 lb. of steam per square foot per minute, or about forty drops per square inch per minute. This rate can be estimated to be at least ten times, and probably nearer fifty times, that obtained in the foregoing experiment, by breathing on the metal surface.

From these considerations there is every reason to expect that the condensation rate on first-line tubes would be more than sufficient to form a continuous film of appreciable thickness covering the entire surface of the tubes, which would greatly impair their conductivity were it not for the dynamic effect of the steam blast that sweeps the moisture around to the leeward face of the tube. The mechanical effect of the impact of the steam against the tube surface therefore appears as a vital factor in the maintenance of a high rate of heat transfer. Now the momentum of the steam may be sufficient to carry it through the first layer of tubes with enough velocity to sweep the surface of the second layer clean, though this is not likely. But there is little doubt that its kinetic energy at the third layer of tubes is so spent that it can no longer break up the water film. This and all successive layers of tubes therefore work at greatly reduced efficiency. Perhaps they are utterly useless, except for the purpose of devaporization of the air, in view of the very small amounts of heat to be removed in this process.

The practical lesson to be drawn from the foregoing considerations is:

1. As much of the condensing surface as possible should be placed in the front line, to condense the maximum amount of steam at first contact.
2. The front-line tubes should be so disposed that the steam may reach them all with the least possible drop in velocity.

The writer hopes shortly to be able to give concrete experimental confirmation of these claims.

Modernization Reduces Costs in Baltimore Ice Plant

Changing to Raw-Water System, Reconditioning of Plant and Substitution of Purchased Power for Steam Drive Saves 65 Cents per Ton of Ice. All Pumps Are Motor-Driven. Duplicate Feeder Lines Insure Continuity of Service

By WARREN VIESSMAN
Industrial Power Department, Consolidated Gas, Electric Light & Power Company of Baltimore

THE Susquehanna Ice Company's plant at Mt. Winans, Baltimore, Md., had for years made ice by the distilled-water process. Because of the relatively high cost of operation as compared with plants making raw-water ice by more economical power and the desire for greater output, the owner decided to modernize the plant equipment and to increase the capacity. The main drives were slow-speed Corliss engines built integral with the ammonia compressors. New uniflow engines were considered, but because of the difficulty of adapting a high-speed engine to the drive, the idea was abandoned. It was felt that the economy would not have been sufficiently improved to warrant the investment. The two methods of drive that were really considered were oil engines and purchased power. The latter method appeared the cheaper and most satisfactory because of low electric rates in Baltimore, occasioned by the combination of cheap hydro-electric power and economical steam generation with coal purchased at low tidewater rates.

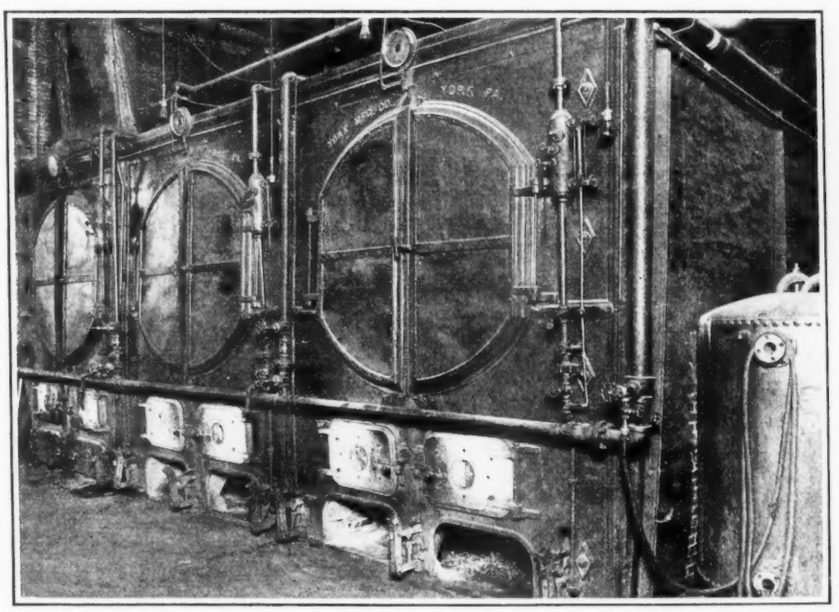


Fig. 1—The low settings of these boilers explain part of the operating losses

A comparison of investment and operating costs revealed a savings with central-station service and since duplicate feeder cables were to be supplied there was no question as to the reliability of service.

Tabulations showed that ice can be made under conditions in this plant for ten cents a ton less with purchased electricity than with oil. Furthermore, the cost of electricity in this locality is much more stable than oil; in fact, electric rates have been gradually reduced, but oil prices have been erratic, with a constant tendency to go higher.

A further deciding factor in favor of electricity was the lower investment cost, as the owner was not desirous of sinking $40,000 additional investment at a 6 per cent interest charge when a return of 12 to 15 per cent might be obtained by investing this amount in a productive enterprise.

Alterations were begun last spring. The three horizontal return-tubular boilers shown in Fig. 1 and all the steam pumps were removed. A portion of the boiler room was utilized as a high-tension electric substation, and additional brick walls were built. This substation has a capacity of 600 kva. and transforms 25-cycle service from 13,200 volts to 440 volts for the large motors and 110 volts for lighting and the cranes. A 500-sq.ft. Fitzgibbons boiler was installed in one corner of the old boiler room and is used for building heating during the colder months and for steaming out lines when necessary. It operates at 15-lb. pressure.

The two existing 16x24-in. single-acting vertical compressors which were direct-driven by steam cylinders, as shown in Fig. 2, were reconditioned by the York Manufacturing Co. This included cylinder reboring at the factory, new pistons, valves, a Nugent oiling system and other details. The steam cylinders, together with the piston rods, crossheads and connecting rods, were removed. The crankshafts were relieved of the flywheels and special 200-hp. 100-r.p.m. Electric Machinery Co.'s synchronous motors of the built-in type with flywheel effect in the rotor were installed, as illustrated in Fig. 3.

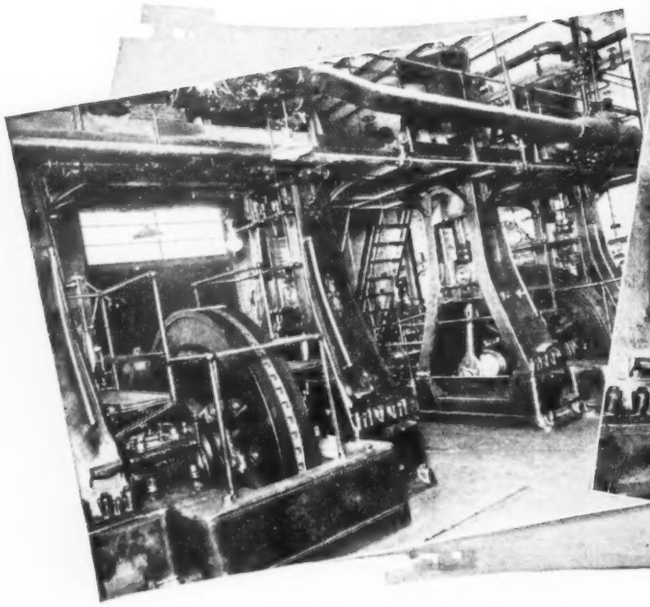


Fig. 2—The two compressors were direct connected to steam engines

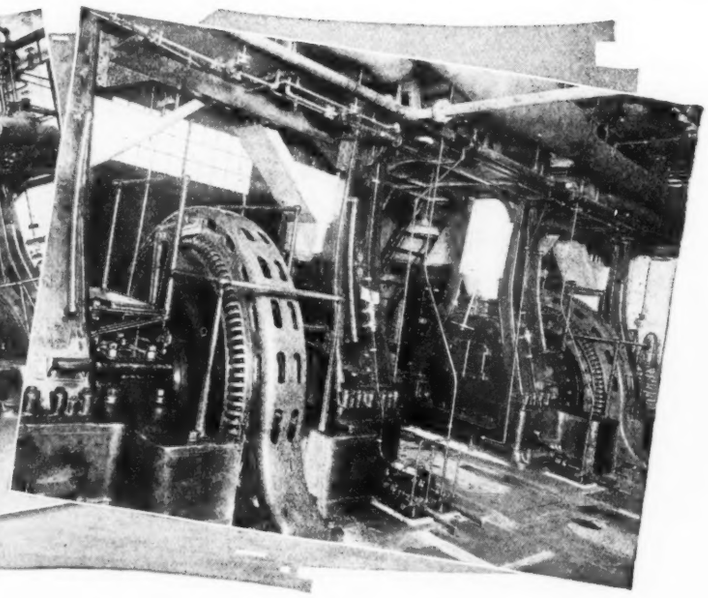


Fig. 3—Synchronous motors replaced the steam drive and the flywheels were removed

In addition, a two-cylinder 7½x7½-in. compressor, Fig. 4, belted to a 30-hp., 200-r.p.m. motor with Lenix idler was installed. This machine is intended to hold the temperature of the brine in the tank and the temperature in the box when the main compressors are shut down. It is guaranteed to make 11 tons of ice in 24 hours when operating under 20-lb. back pressure and 185-lb. condensing pressure. For agitation air two belt-driven 14x9-in. Pennsylvania air compressors, Fig. 5, belted to 40-hp. motors, were placed in another section of the old boiler room. One of these compressors is a spare, and each can furnish sufficient air for 2,100 cans.

An additional ammonia condenser of the shell-and-tube type containing 1,491 sq.ft. of tube surface was installed in the new tank room.

Three electrically driven centrifugal pumps were installed. Two are rated at 15 hp. each and 900 gal. per min., the other one at 10 hp. and 600 gal. One pump is used to take condenser cooling water from a pond and circulate it through the condensers. A second pump takes the water after it leaves the condensers and returns it to the pond, while the third is a spare.

The two existing brine tanks were reconditioned and new ammonia pipe coils installed. In the oldest, which was installed in 1908, 2,600 ft. of 1¼-in. ammonia pipe was placed. The second tank was installed in 1912 and was refitted with 2,500 ft. of pipe. Both were equipped throughout with the necessary air mains, laterals, rubber tubing, valves and fittings for connecting the air compressors with the drop-pipe brackets in the freezing cans.

An additional brick tank room was constructed to accommodate a new ¼-in. steel-plate tank 74 ft. 7 in. long by 25 ft. 1 in. wide and 48 in. high. It contains

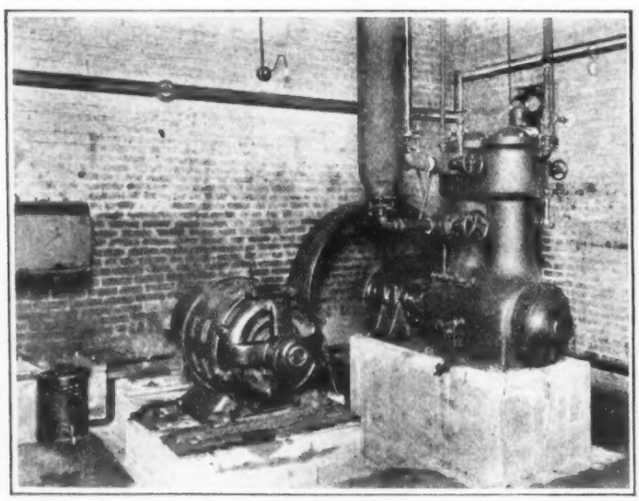


Fig. 4—Small auxiliary ammonia compressor for light loads

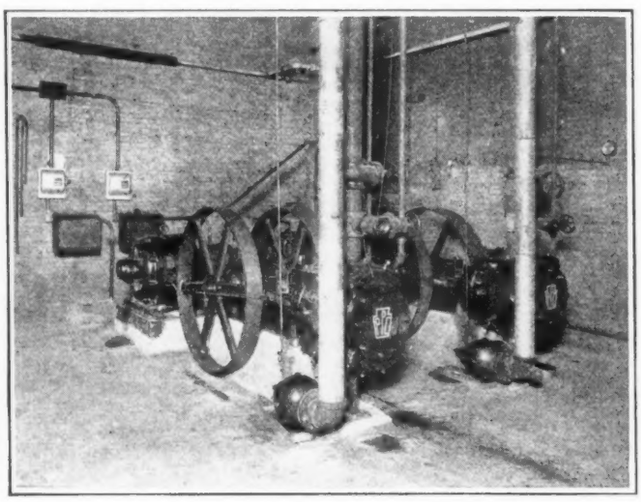


Fig. 5—To supply agitation air two compressors were installed

14,800 ft. of 1½-in. ammonia pipe and is arranged so that 640 cans can be accommodated. One new 30-in. by 11-ft. accumulator has been supplied.

The two small steam engines driving the four old brine agitators were replaced by two 5-hp. motors, and two motor-driven agitators were fitted to the new tank.

The total can capacity of the brine tanks is 1,767 300-lb. cans. The ice box has been enlarged to accommodate 1,200 cakes of ice and is arranged with both brine and ammonia coils for cooling. All the electric equipment, with the exception of a few small direct-connected motors, was supplied, installed and wired by and under the supervision of the Consolidated Gas, Electric Light & Power Co. All ice-making equipment was supplied and installed under the supervision of the York Manufacturing Co. Miscellaneous machine work was done by Wallace & Stebbins. Building construction was done by F. L. Jacobs.

TABLE I—ESTIMATED YEARLY COST OF ELECTRIC PLANT OPERATION

Output 30,000 tons annually. Based on actual operation, June to October, 1926

Investment:		
All electric equipment including installation and wiring cost		$25,000.00
Fixed charges:		
Interest, per cent	6	
Depreciation, per cent	4	
Insurance and taxes, per cent	2	
Total fixed charges	12	$3,000.00
Electricity:		
30,000 × 60 kw.-hr. per ton = 1,800,000 kw.-hr., at 1.14c		20,500.00
Fuel for heating:		
20 tons coal at $6		120.00
Labor:		
1 Chief engineer at $45.00	$2,340.00	
2 Night engineers at $38.00	3,960.00	
1 Electrician at $30.00	1,560.00	
3 Oilers and ice pullers at $25.00	3,900.00	
Total		11,760.00
Supplies and repairs:		
25c. per ton × 30,000		7,500.00
Total		$42,880.00
Cost per ton		1.43

TABLE II—ESTIMATED YEARLY COST OF OIL ENGINE PLANT OPERATION AND INCLUDING FIXED CHARGES

Output 30,000 tons annually

Investment:		
Two 200-hp. Diesel engines installed		$26,000.00
Two 200-hp. Diesel engines driving 140-kw. generators		33,000.00
200 hp. of electric motors, wiring and installation		7,000.00
		$66,000.00
Fixed charges:		
Interest, per cent	6	
Depreciation, per cent	8	
Insurance and taxes, per cent	2	
Total	16	$10,580.00
Fuel:		
6 gal. per ton × 30,000 = 180,000 gal. at 6½c		11,700.00
Lubricating oil:		
1-10 gal. per ton × 30,000 = 3,000 gal. at 55c		1,650.00
Labor:		
1 Chief engineer at $45.00	$2,340.00	
2 Watch engineers at $38.00	3,960.00	
1 Electrician at $30.00	1,560.00	
4 Oilers and ice pullers at $25.00	5,200.00	
Total		$13,060.00
Supplies and repairs:		
30c. per ton × 30,000		9,000.00
Total		$45,990.00
Cost per ton		1.53

The decreased operating costs of the new equipment amply justified the expenditure.

In 1925, 22,118 tons of ice were produced by steam operation. To do this, 3,940 tons of coal were used, or 5.614 tons of ice were produced per ton of coal. The total operating cost of producing ice with the steam plant was $2.28 per ton.

From June to October, 1926, an average of 125 tons a day was made with electricity. The output averaged 140 tons a day for July and August and the maximum daily output was 160 tons. With raw-water operation the plant capacity has been increased 45 per cent with the addition of only an 11-ton ammonia compressor, which is used for holding temperatures when the main plant is shut down. The operating cost per ton of ice produced has been reduced to 70 per cent of the steam operating cost. Additional refinements in plant operation and adjustment are being made, and it is expected that for 1927 a ton of ice will be made on less than 60 kilowatt-hours.

The decrease in cost brought about through modernization of this plant can be duplicated in many others. With present-day water purification systems, which make satisfactory raw-water ice possible, there is no reason in the use of distilled water. It is this demand for steam that makes economical power impossible until a raw-water system is adopted.

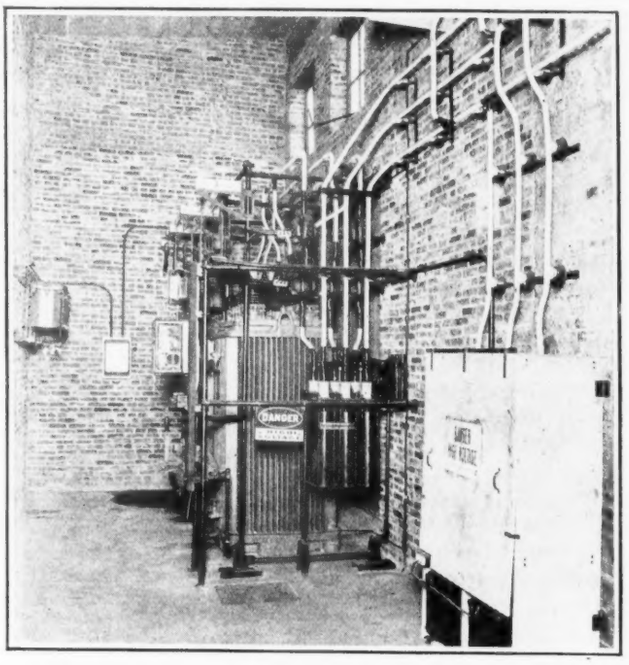


Fig. 6—High-voltage transformers located in old boiler room

Steam Corrodes Iron

Steam in the absence of oxygen attacks iron to a very slight extent at 650 deg. F. The action increases rapidly with the temperature so that serious damage may result in time at temperatures around 1,200 deg. F. It has even been shown that in steam boilers, with an oxygen concentration in the water of less than 0.1 c.c. per liter, a small amount of gaseous hydrogen (under 0.1 c.c. per liter) is evolved at a temperature of 585 deg. F. The amount evolved increases with the temperature within certain limits not yet fully defined.

The action of steam on iron at high temperatures produces magnetic oxide of iron according to the reaction:

$$3Fe + 4H_2O = Fe_3O_4 + 4H_2.$$

This is becoming a more important practical consideration, owing to the present tendency toward higher pressures and superheating in modern steam power plants. Already, signs of deterioration have been observed in steel superheater tubes. It has been found that steel, wrought iron, malleable iron, and white and gray cast iron are all subject to attack, but the high chromium and nickel-chromium-iron alloys are much more resistant under these conditions.—*Mechanical Engineering.*

Charts Simplify Hydraulic Computations

By R. L. LIVINGSTON

IN HYDRAULIC-TURBINE practice runners are designated by certain "type characteristics," such as "type 35," "type 90," etc. The type or "specific speed" of the wheel indicates for what service it is intended. In general, it may be said that the high-specific-speed wheels are used where the head is low or the power large, and the low-specific-speed wheels where the head is relatively high. We find Pelton-type wheels with specific speeds in the neighborhood of 4, Francis-type wheels from about 10 to 100, and above that the new screw type of runner.

Specific speed, taking into account as it does the horsepower, head and revolutions per minute, is an excellent basis for comparing wheels. Given the set of conditions under which a turbine operates, one can easily picture the runner by computing the specific speed. Unfortunately, the formula for specific speed[1] is a little cumbersome, being practically insoluble without a slide rule and difficult with anything except a special "log-log" rule. The specific-speed chart is intended to perform this calculation with the least possible trouble and with an accuracy as great as with a 10-in. slide rule.

Not only is it possible to solve for specific speed, but with a given specific speed and any two of the three variables that go to determine the specific speed, the third can be obtained. To the operating engineer it is always well to know at what specific speed his turbine is running for, obviously, if it is operating at other than its rated specific speed, the efficiency will be lowered.

Chart Gives Relation Between Speed, Head, Horsepower and Specific Speed

To illustrate the use of the chart, we will suppose in a given installation that the horsepower at maximum efficiency is 2,000, the speed is 225 r.p.m. and the actual effective head is 40 ft. What will be the specific speed?

It will be seen that line 3 of the chart is divided uniformly; this is the "support," or pivot line. A dummy scale is laid out on it for convenience, but the scale divisions have no meaning. To solve the problem just given, draw a line connecting 225 r.p.m. on scale 1 with 2,000 hp. on scale 2. This line crosses the dummy scale at about 64.5. From this point draw a line through 40 ft. on scale 4. This line, when extended, cuts the specific-speed scale 5 at 100, which is the answer.

Had any other of the quantities been desired, with a given specific speed, the procedure would have been practically the same, except that the quantities would have been taken in a different order. The final construction in every case will be equivalent to that shown by the dotted lines.

With a fixed specific speed of 50 and a head of 70 we would have obtained an intercept on the dummy of 64.5. Then, we could produce 1,000 hp. at 320 r.p.m., 500 hp. at 455 r.p.m., 5,000 hp. at 142 r.p.m., or any pair of values intersected on scales 1 and 2 by a line drawn through 64.5 on scale 3. The diameter of the turbine would vary in each case, of course. To illustrate further, we will assume that the specific speed is given as 20, the head as 100 and the r.p.m. as 180. What horsepower can we produce? Connect 20 on scale 5 with 100 on scale 4 and the intersection on the dummy will be seen to be 55.7. Connect this point with 180 on the scale 1 and the horsepower produced is read as 1,250 on scale 2.

Practical Application of the Speed Chart

Another factor, useful not only in hydraulic turbine work, but also with centrifugal pumps, is the constant represented by the Greek letter Φ, pronounced "phi." "Phi" is the ratio of the rim speed of the runner to the spouting velocity of water (that is, the velocity at which water would spout from an orifice under the given head). This ratio equals $\frac{\pi DN}{720} \div \sqrt{2gh}$, where D is the diameter of the wheel in inches, N is the revolutions per minute, h is the head in feet and g is 32.2.

This factor will vary with the specific speed and is an additional guide to the type of the wheel. In impulse wheels it is usually figured as 0.45, while in Francis-type wheels it varies from this value up to around unity. "Phi" will vary widely when a wheel is tested over a wide range, and at runaway speed may be considerably above unity. In centrifugal pumps values of "phi" may be found in the neighborhood of 1.2, but may differ widely.

Suppose a pump of 12 in. diameter of impeller is driven by a direct-current motor at 1,700 r.p.m. and delivers water against a head of 100 ft. per stage. The solution is indicated by the dotted lines. Connect with a straight-edge 12 in. on the scale A with 1,700 on B. This line cuts scale S at 88, which is the rim velocity. Connect this point with 100 ft. on scale X. Then Φ is read on scale Y as 1.1.

Other uses of this chart are obvious. The center column marked S gives the peripheral velocity in feet per second. If it is desired to know at how many revolutions per minute a 20-in. cast-iron runner can be driven, for example, assume a safe top speed (say 80) and connect 20 in. on scale A with 80 on S and read about 910 r.p.m. where this line extended cuts scale B. Now look alongside the right-hand side of the last column for typical motor and generator speeds. These are shown at the right. By dropping down to 900 r.p.m. (a usual speed) it is seen that a top speed of 78 ft. a second is obtained.

By studying this chart, a number of other uses become obvious. A value of Φ and head per stage might be assumed. A value of $\Phi = 1.0$ and a head of 150 ft. gives a top speed of 100 ft. per sec. By moving a straight-edge around and getting various intersections on scales A and B, all the various combinations of diameters and r.p.m. to give this condition may be

[1] Specific speed = R.p.m. $\times$ Hp.$^{\frac{1}{2}} \div$ Head$^{\frac{5}{4}}$

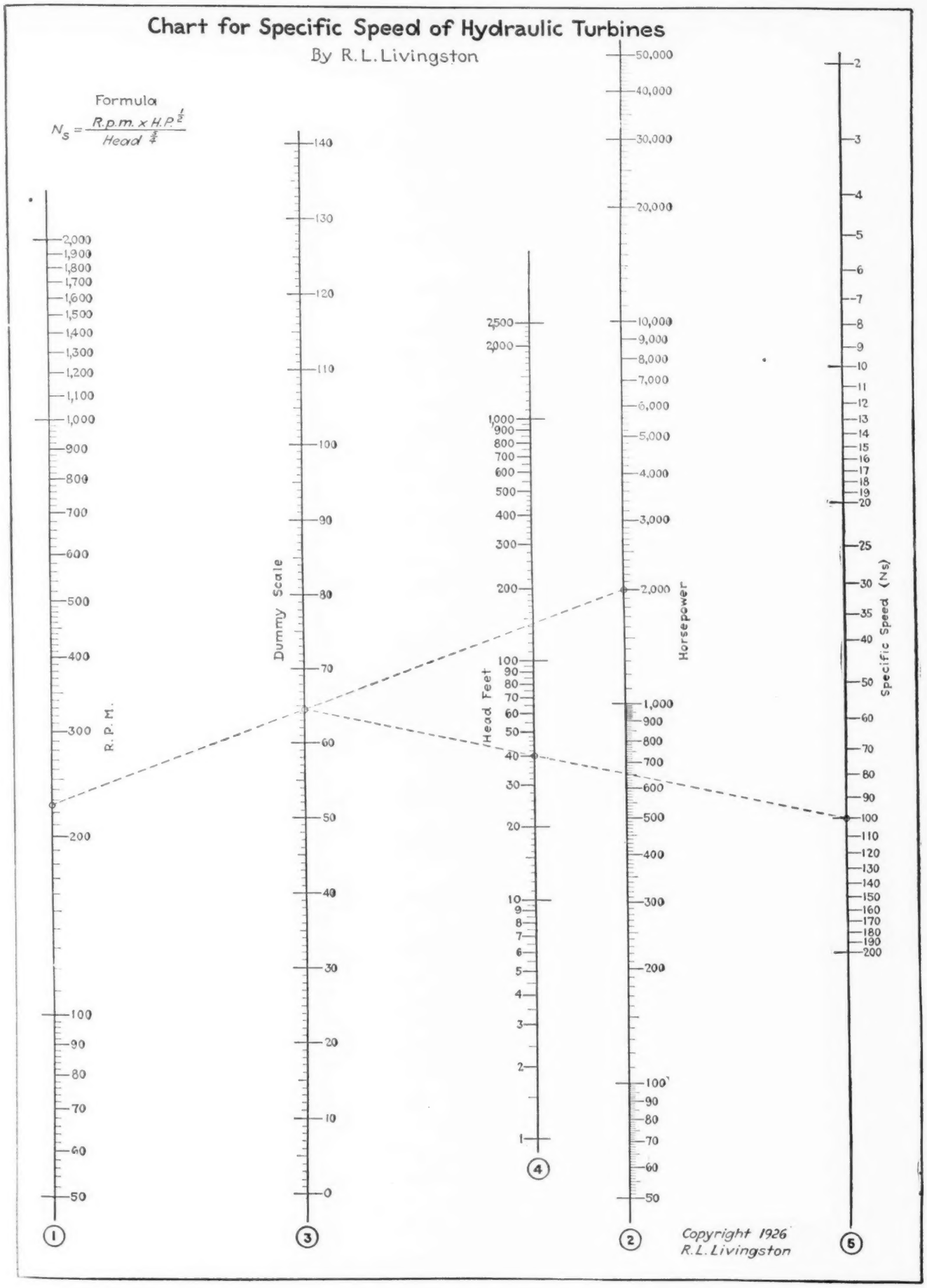
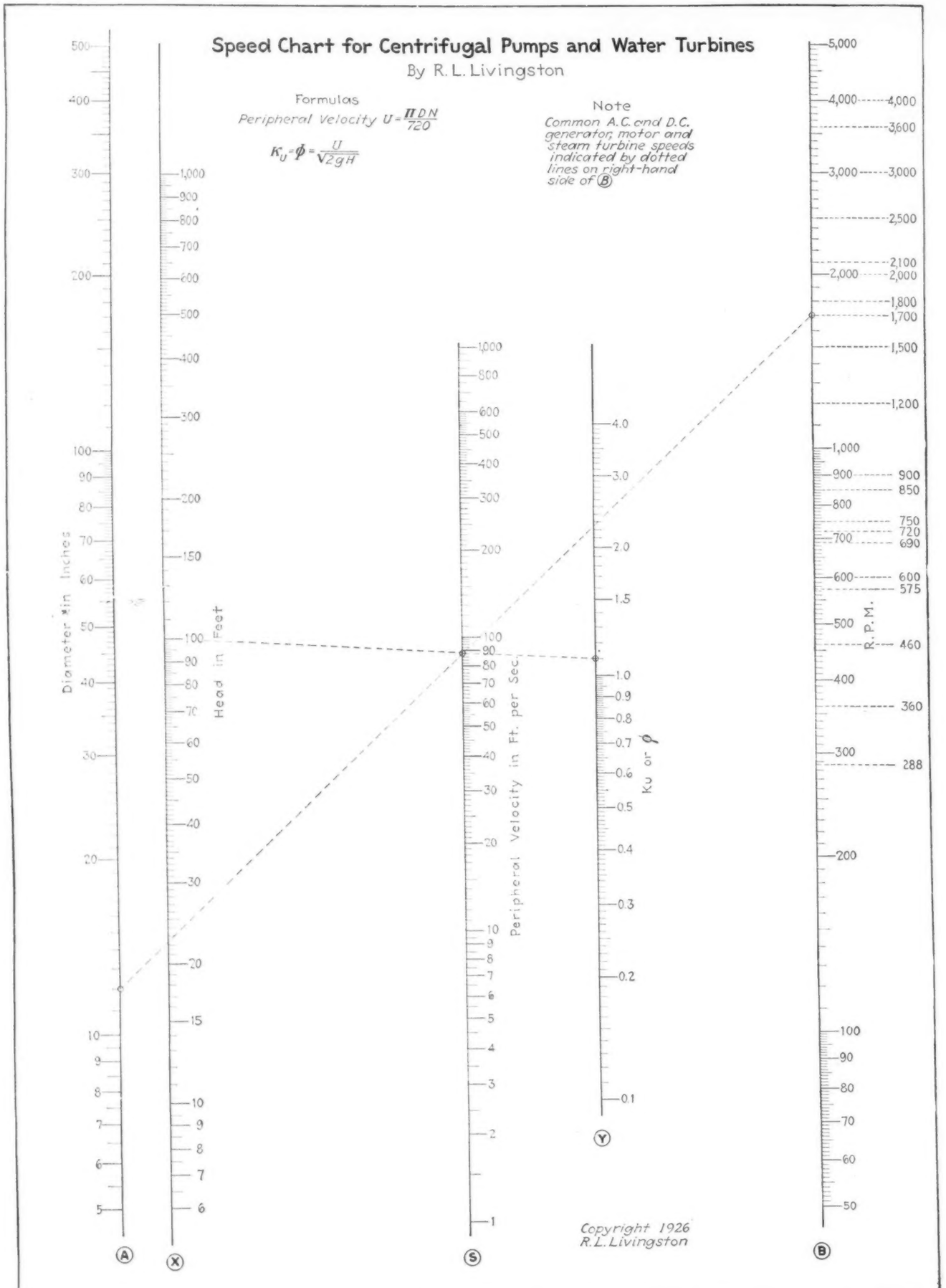


Chart for Specific Speed of Hydraulic Turbines
By R. L. Livingston
Formula
$N_S = \frac{R.p.m. \times H.P.^{\frac{1}{2}}}{Head^{\frac{5}{4}}}$
R. P. M.
Dummy Scale
Head Feet
Horsepower
Specific Speed (Ns)
Copyright 1926
R. L. Livingston


Speed Chart for Centrifugal Pumps and Water Turbines
By R. L. Livingston
Formulas
Peripheral Velocity $U=\frac{\pi DN}{720}$
$K_U=\phi=\frac{U}{\sqrt{2gH}}$
Note
Common A.C. and D.C. generator, motor and steam turbine speeds indicated by dotted lines on right-hand side of (B)
Diameter in Inches
Head in Feet
Peripheral Velocity in Ft. per Sec.
Ku or ϕ
R. P. M.
(A)
(X)
(S)
(Y)
(B)
Copyright 1926
R. L. Livingston

found. Thus 48 in. diameter and 470 r.p.m., 36.25 in. diameter and 625 r.p.m., 25.5 in. diameter and 900 r.p.m. may be used. In design or selection work this last use of this chart should prove invaluable, for it would save a number of repeated slide-rule calculations that admit of error.

The use of these two charts permits the solution of a large number of turbine and centrifugal-pump problems which would otherwise prove difficult and tedious. In the use of charts of this sort it is suggested that a straight line be scratched with a scriber on a triangle or strip of celluloid. The side on which the line is scratched should always be held against the paper. Further, if a very fine hole is drilled at about the center of this line, a needle, pin or even a sharp-pointed pencil can be used to pivot the whole triangle or celluloid strip about the point taken on the support line. If proper precautions are taken, these charts will prove sufficiently accurate for most practical problems.

Exhaust Ejectors for Steam Engines

The Feasibility of Using the Kinetic Energy of the Exhaust To Create a Vacuum Is Real—Success of Experiments Indicates the Possibility of Lower Steam Consumption and Reduced First Cost

By W. TURNWALD

IT IS only recently that attempts have been made to increase the over-all efficiency of steam engines by utilizing energy which under certain conditions is contained in the steam as it is being exhausted. This energy is usually termed the loss due to incomplete

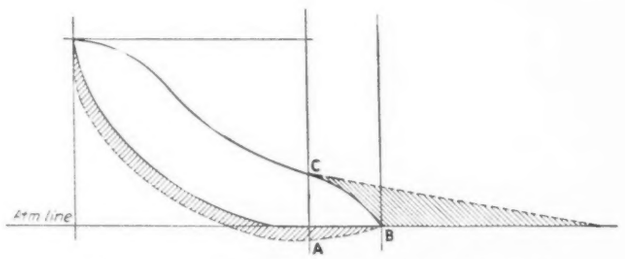


Fig. 1—Uniflow diagram showing loss due to incomplete expansion

expansion, and the exhaust ejector is one of the means at disposal to convert this loss into usefulness.

Comparisons between the steam engine and the two-stroke-cycle gas engine as far as application of ejector exhaust is concerned, have been made at times and in order to avoid misunderstanding it may be well to point out that the exhaust ejector is applicable primarily to multi-cylinder engines of the uniflow type.

Modernizing an Old Principle

Its principle is as old as the locomotive. Every locomotive, with its blast pipe, stack and smokebox, contains the very elements that go to make up the exhaust ejector as it is now used with multi-cylinder uniflow engines. The difference is that the ejector action with the locomotive is exerted upon the flue gases of the boiler, while with the uniflow engine it is used to evacuate a cylinder different from the one furnishing the blast.

In Fig. 1 is shown schematically an indicator diagram with the loss due to incomplete expansion and the increase in diagram area obtainable by utilizing the otherwise wasted energy contained in the steam. It will be apparent that best results will follow if it is possible to create the lowest pressure in the engine cylinder at the point where the piston closes the exhaust port, that is, at point *A*. In order to accomplish this, a certain degree of continuity of ejector action is necessary because it must be remembered that the engine piston, when approaching the closing point of the exhaust ports, moves with rapidly increasing velocity; therefore, in order to maintain a given pressure in the engine cylinder, the ejector must exhaust steam at a rate at least equal to the instantaneous piston displacement. From this it follows that a single-cylinder engine with its intermittent exhaust, does not give promise of any decided success.

Possibility of Obtaining a Vacuum

Coming back to the locomotive, we usually find a two-cylinder engine with cranks at 90 deg., giving four exhaust puffs per revolution. Such an engine running at 200 r.p.m. will create a very even draft for the fire, because at this speed it furnishes 13 exhaust puffs per

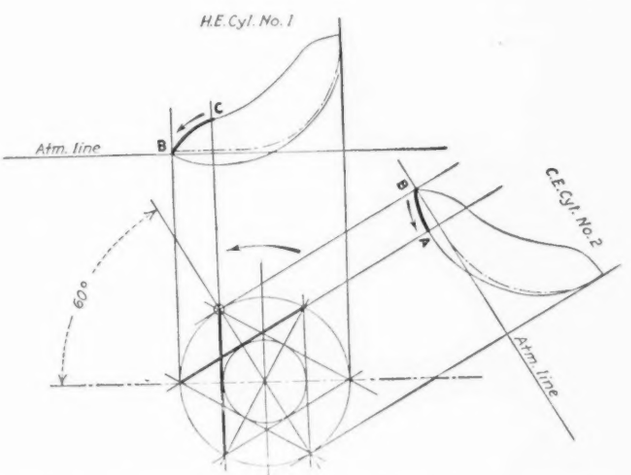


Fig. 2—Interrelation of the exhausts of two cylinders in a 6-cylinder engine

second. Similarly, with a stationary multi-cylinder uniflow engine we are able to create, at customary speeds, as much as 40 to 50 puffs per second. From this it would appear that continuity of ejector action is more than assured. In particular, for three cylinders with

cranks at 120 deg., it appears from Fig. 2 that we may count on almost continuous sequence of positive exhaust periods. The term positive exhaust period is intended to apply to the part *CB* of the diagram shown in Fig. 1. Furthermore, at any time, during which the exhaust phase *CB* takes place in one cylinder, another cylinder runs through the phase *BA*, so that we may be assured of the best possible co-ordination of exhaust ejector action. The simultaneous occurrence of the two exhaust phases is also indicated in Fig. 2.

A cross-section through a cylinder block, comprising three cylinders, equipped with exhaust ejector, is shown schematically in Fig. 3. Again, the similarity between this apparatus and the locomotive smokebox is striking. The simplest way to express the action of such an apparatus is to state that each cylinder, instead of exhausting against the static pressure in the exhaust pipe, exhausts against the dynamic pressure that is maintained in the equalizing chamber.

Ejector Decreases Steam Consumption

The effect of the exhaust ejector on engine performance is shown on the curve sheet, Fig. 4. The curves give the per cent water rate in pounds per i.hp.-hour plotted against mean effective pressure. The dashed

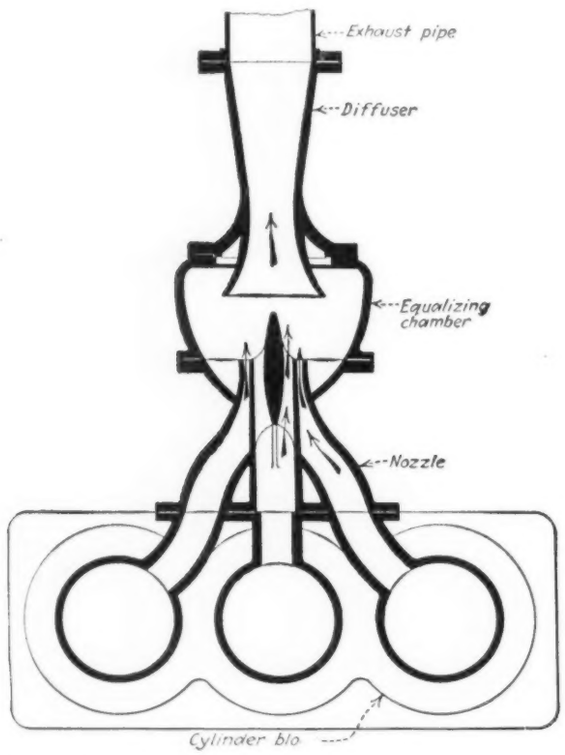


Fig. 3—Schematic layout of an exhaust ejector

curve applies to the engine without exhaust ejector, while the full line curve denotes water rates of the engine equipped with the exhaust ejector. It is apparent that the divergence between the curves increases with increasing mean effective pressure. Both curves have a common origin, the point of complete expansion, in which there is no exhaust ejector action. It may be well to state that these curves apply to the perfect engine, or the engine having clearance and compression like the real engine, but no condensation losses.

There are two ways in which the action of the exhaust ejector may be utilized. One is to retain for a given power output the cylinder dimensions of the ordinary engine, equip it with the exhaust ejector and obtain the benefit of increased economy, as indicated for one distinct m.e.p. in Fig. 4 by a vertical line, or gain the

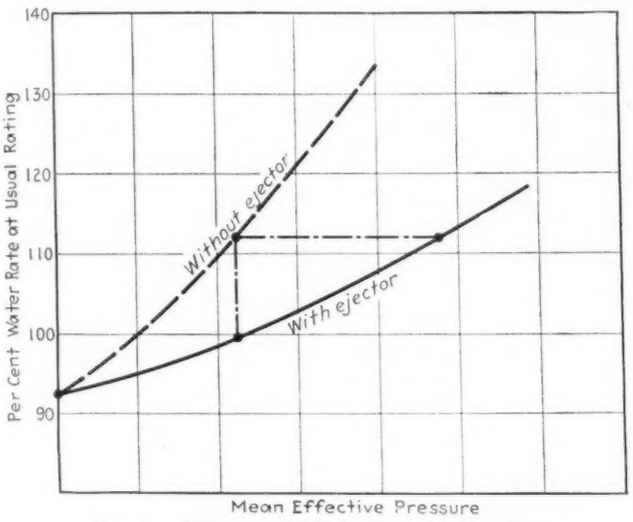


Fig. 4—Increased efficiency with ejectors

benefit of greatly reduced engine size without increase in the water rate, as indicated in Fig. 4 by a horizontal line.

From present experience it would be safe to state that for average steam conditions an increase in economy at full load of about 10 per cent will be obtainable or a reduction in cylinder size of about 40 per cent. This latter figure must not be construed to mean that it will bring about a reduction in overload capacity of the engine, because this 40 per cent increase in m.e.p. is obtained with a very slightly later cutoff. Uniflow engines of the multi-cylinder type are rated usually to develop full load with a cutoff not to exceed 15 per cent; therefore the overload capacity of the engine in all cases by far exceeds the overload capacity of the generator.

[Although the application of the ejector exhaust is still largely in the experimental stage, it would seem to have practical possibilities.—Editor.]

Heat Transfer in Condensers

The results of tests to determine the rate of heat transfer in condensers are usually expressed as heat transfer coefficient; that is, the rates as B.t.u. per hour per square foot of condensing surface, per deg. F. average temperature difference between the ammonia and the cooling water.

A question arises as to the proper average temperature difference to use, since the condenser is complicated in action, and may be divided into three zones, in which the ammonia is precooled, condensed and aftercooled. However, since it is probable that over 80 per cent of the surface is used in condensing the ammonia, and moreover even a larger percentage of the total heat transfer takes place in the condensing zone, according to T. K. Sherwood, it seems reasonable that no great error is made in using the logarithmic mean difference between the temperature of the condensing ammonia and of the entering and leaving cooling water.

Forty Years an Educator

THE testimonial dinner tendered to James Herbert McGraw by over a thousand of his friends and admirers December 17 was a well merited tribute to one who has passed his life in the service of industry.

Tempted at one time to allow his course to be diverted in the direction of national politics, where his qualities would have won public recognition, he was convinced that he could be of greater service through the influence of a great battery of engineering and industrial papers conducted in accordance with his ideals.

To the leaders and the personnel of the professions and industries that he has thus served, he stands in the same relation that one who has served in a high official position does to the public.

And their appreciation of this service is manifested by the spontaneity and cordiality with which they have joined on this occasion to do him honor.

We have characterized him as an educator, and it is true. No president of a university has had a greater opportunity to mold thought, to make character and to influence the lives of men.

His student body, the subscribers to the journals the publication of which he controls, numbers a quarter of a million, while apart from these the book company that bears his name and acknowledges his leadership has put at the service of the profession over eleven hundred titles of the best of engineering literature.

The industries to which he attached his interest have had an exceptional growth; from the horse car to the interurban special; from an experiment in town lighting to superpower; from pressures of eighty pounds and units measured in hundreds of horsepower to fourteen hundred pounds and units of a hundred thousand kilowatts; from the simple processes of the past century to the synthetic chemistry, the scientific mining and the civil engineering triumphs of today.

And he has ridden and developed with them and been, in some of them at least, a dominant factor. It is fitting that while his guiding hand is still strong and his masterly brain still active, the beneficiaries of his service should gather and testify to their appreciation of his qualities as a man and of the leadership "which elder days shall ripen and confirm to more approved service."

Hot Air and the Stoker

THE limit in preheating air for supply to a chain-grate stoker seems to be about four hundred degrees F. Above this temperature the cast-iron links tend to grow and make the stoker inoperative. For an underfeed stoker the temperature may safely be raised to five hundred and fifty or six hundred degrees F. so far as experience to date indicates. Even with rather inferior coal, clinker troubles seem not to be increased. The fuel bed is carried thicker, but is of more porous texture with less cold fuel at the bottom. There is no evidence of a tendency of the coal to agglomerate or coke. The fuel bed is noticeably smoother, and a higher CO_2 content is obtainable in the flue gas.

Three or four years ago, Honda, the Japanese metallurgist, reported the demonstration of a new critical temperature for the iron-carbon system at 425 deg. F. Above this temperature cementite breaks down and causes growth of the metal. The whiter the iron the slower the process. This would make it appear that if a stoker be furnished with air hot enough to maintain cast-iron parts at or above 425 deg. F., growth of the metal is inevitable, although it may be very slow.

Experience alone can demonstrate the practical bearing of these observations, but it is helpful to know the kind of trouble to be expected. There is certainly no cause for alarm at present, but it is well for the engineer to have an eye to the future.

Preheated air has come to stay. Promoted for use with pulverized coal, it has developed marked gains for the stoker. With the growing use of regenerative water heating the air preheater is coming to be more important as a means of decreasing the flue-gas heat loss. These gains the power-plant engineer will not cheerfully relinquish.

Stoker builders have adapted their product structurally to the use of hot air. They must remain alive to the possible effects of high temperature on the metal used and, at the first appearance of trouble, be ready with a remedy.

Welding To Avoid Embrittlement

WHEN Alexander the Great found he could not untie the famous Gordian knot, he cut it with his sword. This old story and the proverb, "There is more than one way to cook a goose," might well be inscribed on the walls of every engineer's office. The good engineer is always a man who can find another way when the customary routes are closed.

These thoughts were inspired by a recent remark of Professor Christie. He was presenting his report as chairman of the subcommittee on embrittlement of boiler metal at the annual meeting of the joint research committee on boiler feed-water studies. As pointed out by Professor Christie, practically nothing is yet known as to the mechanism of the so-called "caustic" embrittlement. It *is* definitely known that embrittlement occurs and that in boiler practice it is found only in the riveted joints of drums. This being the case, said Professor Christie, why not consider the possibility of cutting this Gordian knot by the use of drums fabricated without rivets, thus avoiding all trouble of this sort until further research makes other remedies available? In particular he suggested that it might be feasible to fabricate drums by welding, annealing the

whole drum after the welding operation to release strains set up either by welding or the preliminary curving of the plate. While he did not specify the kind of welding, he apparently had in mind both forge and autogenous welding.

In this connection it is worth noting that forge-welded boiler drums are now being made in Germany. Some of these, it is said, are hydrostatically tested to three or four times the working pressure. Such a test, while stressing the metal beyond the elastic limit in some cases, proves the soundness of the weld. This point having been settled, the entire drum is annealed to relieve the strains set up by the test pressure. While Professor Christie himself made no mention of test pressures, this matter should be considered carefully in connection with welding and annealing.

It should be clearly understood that *Power* is not recommending the welding of boiler drums. The A.S.M.E. Boiler Code Committee, the recognized authority on boiler construction, has not yet seen fit to authorize their use. This position is justified until the safety of such drums, as made commercially, is established beyond question.

Across-the-Line Starters Should Be Applied with Care

FOR a long time it was generally conceded that polyphase alternating-current motors larger than five horsepower should be equipped with some type of reduced-voltage starter. A state of development has been reached where many engineers consider that such a rule is not generally justified, when the size of the average motor is compared with the capacity of the modern power system and distribution lines. Experience has shown that this conclusion is based on sound engineering. However, it is not advisable to attempt connecting alternating-current motors directly across the line at starting unless the factors influencing such applications are thoroughly understood.

System capacity has generally been considered one of the factors determining how large a motor can be connected directly to the line without causing an objectionable disturbance. Of equal importance is regulation. A comparatively small system with good regulating characteristics might be less disturbed by starting a given motor than a much larger one that has poor regulation. On one system of about four thousand kilowatt capacity, twenty-two hundred volt motors of five hundred horsepower rating have been started by connecting them directly across the line. There is not sufficient experience to warrant the conclusion that this is good practice in all cases

Not only the motor's speed, but also the condition of its windings, must be considered. Slow-speed alternating-current motors have high internal reactance, which tends to limit the starting current to reasonable values. A synchronous motor that operates at one hundred revolutions per minute takes no more current at starting, when connected directly across the line, than a motor having a speed of one thousand and started on sixty per cent normal voltage. When starting on full voltage, the inrush current in the windings sets up magnetic forces that tend to distort the coils. Unless the end windings are properly supported, as they are in many of the modern machines, these magnetic forces may permanently distort the coils or cause insulation failures.

The load connected to the motor and the methods of connecting have an influence upon the success attained with starting an alternating-current motor by connecting it directly across the line. A lightly loaded direct-connected motor might start with very little distress to the power system or the driven machine. On the other hand, if the motor is connected to a high inertia load, through a chain drive, the results may be objectionable to the power source and to the drive or machine.

Connecting the motor directly across the line simplifies the starting process, reduces the cost of starting equipment and, when properly applied, reduces the maintenance costs. But care must be exercised in making these applications, or serious trouble may occur costing more than any saving in the price of starting equipment. Reduced costs and simplification are desirable qualities, but not at the price of increased maintenance.

High Rotative Speed Need Not Be Objectionable

THERE seems to be a current feeling that high rotative speeds in both steam and internal-combustion engines are objectionable. On the other hand, the proponents of increased revolutions point out several advantages, such as lower first cost and decreased installation expense, to disprove the popular belief.

The average engineer has become so familiar with slow-speed reciprocating engines that he assumes as a matter of course that there is an inherent necessity for long-stroke slow-moving machines. Some who have gone a little deeper into the subject, decided that the inertia of the reciprocating parts would, at high speeds, be so great as to destroy bearings and shafts rapidly, if not the frames. Inertia forces are by no means wild horses impossible to harness, and a designer can, with no great trouble, so choose the material and shape the parts that the inertia stresses are kept well within reason. In fact, one English vertical steam engine, although operating at speeds considered excessive, was long noted for its watch-like balance. Troubles occurring in high-speed machines are but indications of an inferiority on the part of the designer.

With floor space valuable and material costs high, the advocates of higher rotative speeds have some arguments that will not be downed by hide-bound traditions.

Three Score Years of Boiler Insurance

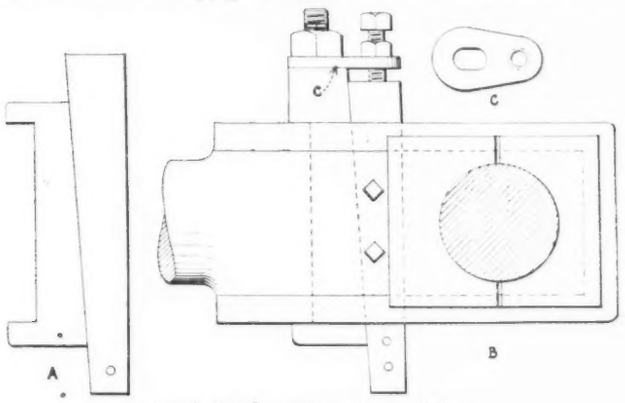
OUR congratulations to the Hartford Steam Boiler Inspection and Insurance Company which completed in October of this year sixty years of useful existence. The practice, already established in England, of avoiding boiler explosions by inspection was backed up by an indemnity in case of failure and boiler insurance became a fact.

The Hartford has, however, been much more than an underwriter of losses from boiler explosion. It has led in the establishment of safe practice in design, construction and operation. Its experience and practice are written into the codes of today and its requirements are controlling factors in boiler specification. Its inspections are accepted in lieu of those of government officials in most, if not all of the states where boiler inspection is compulsory. We wish for it many years of continued prosperity.

Practical Ideas From Practical Men

Making an Old Engine Safe

About three years ago I had trouble keeping the crankpin adjusted on an old engine which was used for pumping. The engine, which had a cylinder 16-in. bore by 14-in. stroke, ran at 232 r.p.m. was fitted with the old fashioned strap, gib and cotter for both the crank-



Lock holds cotter in position

pin and crosshead, the cotter pin being held fast by two setscrews. The cotter frequently worked loose and made the engine dangerous, so I designed a new gib with a locking device for the cotter.

The illustration shows the old gib and cotter at *A*, and the new gib and cotter are shown in place at *B*. One end of the locking plate *C* has a $\frac{1}{2}$-in. tapped hole to take a setscrew, which prevents the cotter working loose. The other end of the plate *C* has a hole $\frac{3}{4}$x$\frac{7}{8}$ in. which prevents it turning on the bolt. There has been no trouble with the engine since this change was made.

Ladysmith, B. C. W. F. COOIL.

The Machinery Erector as a Sales Influence

Manufacturers do not always appreciate the influence the machinery erector may have on their relation with the customer.

The number of repeat orders, future volume of business, resulting from the degree of satisfaction that a customer will feel depends largely upon impressions gained when the new piece of machinery is first put into service. Therefore much depends upon the man who assembles the machine and carries it through the first critical period of operation. Once the owners become familiar with their equipment, they become better able to judge where the fault lies if the machine fails to work as it should.

When a machinery shipment is of sufficient importance to justify having a mechanic accompany it to superintendent its assembly, put it in operation and see that it is properly "broken in," the manufacturer is depending upon him, indirectly, for repeat orders. If he fails to make good, it may be impossible to convince the customer that the machinery is not at fault, and the manufacturer will surely be blamed for any form of trouble that may develop.

Recently at Arica, Peru, a shipment of locomotives arrived from the States. The consignee of this shipment nearly had nervous prostration because the "expert" who came to assemble them had been deported.

This chap had arrived some weeks ahead of the shipment. While he waited he took a few drinks, loafed about the Plaza, argued politics with everyone with whom he could talk, had several fisticuffs and was arrested on occasions until he became a public nuisance and had to be sent home. This made it necessary that the locomotives be assembled and put in operation by native mechanics.

If repeat orders were lost as the result of his unworthiness, his employers were more at fault than was he. They should have known their man before giving him such an important commission. Probably this chap at Arica had the interest of his employers at heart, and we have no evidence that he was lacking in mechanical ability. In his narrowness he could not associate street brawls with possible failure in his work. He exercised the God-given right of all loud-speakers to be an infernal nuisance until some one "socked" him one on the jaw.

In the matter of salesmanship the man who brings home the orders is well paid for so doing. However, the dumb mechanical representative can throw more business out the back door than the high-priced salesman can bring in the front, and he should reap a reward for his conduct commensurate with his methods of procedure.

It is impossible to say how many of these chaps go unrewarded. Any number of dumb-bells go on making blunders, disgusting and discouraging customers and losing business for their firms. Others turn the tide in their firms' favor just at a critical moment by acting wisely and quickly. This brings repeat orders to the salesman, yet the engineer is rewarded only with an assurance of steady employment and the same rate of pay as the less worthy ones who hang in the shadow of discharge continuously.

To eliminate unsatisfactory conditions of this sort, the traveling mechanic should be trained carefully and thoroughly, not only as a mechanic but as a business man. He must have a pleasing personality and tact, be capable of meeting all emergencies unaided, be authoritative but not overburdened with ego, and broadgage enough to see beyond his own department.

The foreigner who works in the capacity of a traveling mechanic does not possess all these qualifications, yet he is a trained man, a thorough mechanic and often an accomplished linguist. Americans commonly have to have a translator while abroad and this is a bad handicap. The foreigner is commonly a more highly educated man than the American even though he is sent out on a comparatively small assignment. We Americans seem to feel that it is necessary to have a small

fortune involved before it is necessary to send out a really high-class engineer. This is entirely wrong and the quality of the representative should remain high no matter how small the amount of business involved. There is one national characteristic in favor of the American as compared to the foreigner, particularly the European. The latter is often obnoxious with his insufferable arrogance, secretive methods and vastly superior attitude.

One bad fault with American experts is that they do not run true to form.

All of which brings us back to the problem of selling. There are more ways of selling machinery than to maintain a fine suite of offices on Broadway, conduct an extensive advertising campaign and hire high-power sales engineers. One of the other ways is to use as much care in selecting the mechanical representative as is used in choosing the "diplomat" with the brief-case and the fat brown cigar.

A. B. NEWELL.

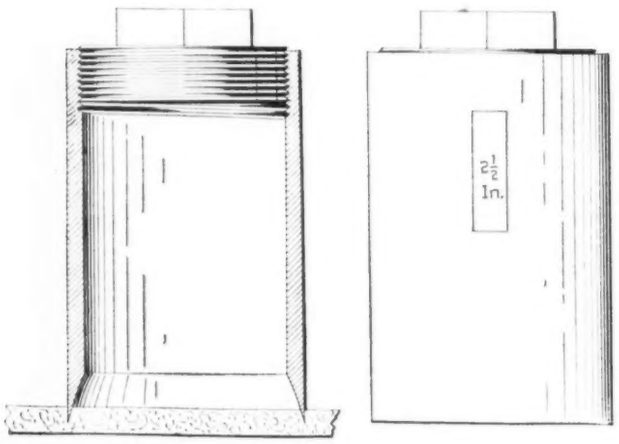
Woodbury, N. J.

Making a Gasket Cutter

Where gaskets are used extensively, some method must be devised to keep a supply ahead of the demand. Very often, for lack of proper sizes, workmen attempt to cut them with a knife, and the result is often a cut finger rather than a good gasket.

Our requirements on gaskets, in common with those of all large power plants, are high, and it is up to our stockroom man to see that there is always a goodly stock upon his shelves or the repair gang just naturally raises the roof.

The stockroom man has his own ideas on gaskets. He wants not only a good appearing serviceable gasket,



Using a pipe coupling as a gasket cutter

but also a quick efficient way to keep his stock ahead. So he cuts the gaskets out of standard sheets and, being left on his own resources, has devised a method to save time.

He uses a series of pipes and couplings which he files out to the proper size. A half-round file and the workbench vise are his tools. When he has filed the couplings to the correct size, they are taken out to the blacksmith, who takes the pieces, heats them to a bright red and with the application of a little potassium cyanide the tempering is soon done.

A block of lead or similar material should be used for the cutting base so that the knife-like edges will not be injured. Cutting gaskets with such tools as shown in the illustration enables one to eliminate nearly all waste, as it is possible to utilize the centers for smaller ones.

E. J. MORRISSEY, Chief Electrician,
Western Utilities Gas & Electric Co.
Aurora, Illinois.

Troubles with Starting Compensators

An experience I had some years ago with induction-motor starters, while making power-factor tests on the equipment in a factory, may prove of value to others

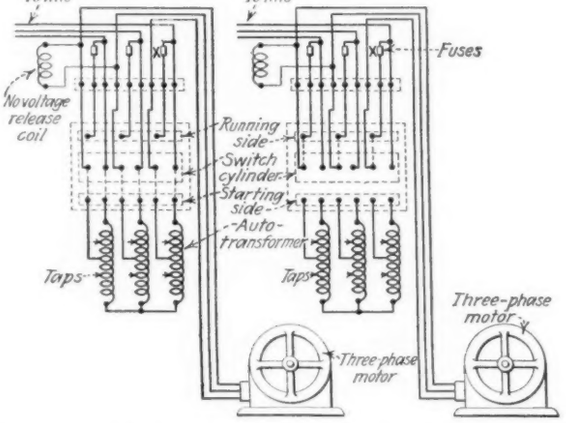


Fig. 1—Compensator in starting position

Fig. 2—Compensator in running position

in the field. Most motors of 10-hp. rating and over are equipped with starting compensators which connect the motor through an auto-transformer to the line. The current for starting is not taken through the fuses, as shown in Fig. 1, because of its relatively higher value than the rating of the fuses. When the motor has come up to speed and the lever pushed back to the running position, the motor windings are connected directly across the line with the fuses in circuit, as in Fig. 2. Thus a heavy overload will blow the fuses.

A test was being made on a 10-hp. motor which ran a load requiring about 6 hp. The instruments were inserted in the motor circuit at the switch box. One of the three phases supplying this motor registered no current on the ammeter, but the motor started easily and apparently carried the light load. We blamed the current transformer for the trouble and spent some time tracing through the auto-transformer connections. The fuses were considered last, unfortunately, and one was found blown. It can be seen from Fig. 1, that the motor was started on three-phase power, but when the compensator was switched over to the running position, the blown fuse at *X* caused an open in one line, hence only one phase of the current reached the motor. Replacing the blown fuse remedied the trouble.

On another motor practically the same trouble was found to exist, but the fuses were good. On removing the oil pan under the compensator, a contact was found to be missing, which was located in the bottom of the oil pan. Its setscrew had loosened and the contact brush had dropped off, opening one line of the motor's running circuit, with the same result as if a fuse had blown.

ANTHONY J. CHRISTOPHER.

Baldwinsville, N. Y.

Comments from Readers

Tuning up the Heating System

I was much interested in an article in the Nov. 23 issue by Carl Wildey, entitled "Tuning Up the Heating System." Mr. Wildey says that "if every engineer would eliminate the oil paints on the ratiators, radiation would improve."

I have just been reading an article on the "Effects of Painting Radiators," which appeared in the "American Society of Heating & Ventilating Engineer's Guide, 1925-26," from which the following table was obtained: "The table shows the effects of painting a two-column 38-in. radiator 10 sections long with different kinds of paints. Steam temperature 215 deg., room temperature 70 deg. F."

CONDITION OF SURFACE	PERCENTAGE OF EFFECTIVENESS
Cast iron bare	100 per cent
Painted with aluminum bronze	80 per cent
Painted with gold bronze	81 per cent
Painted with white enamel	101 per cent
Painted with maroon japan	100 per cent
Painted with white zinc paint	101 per cent

The table would indicate that when radiators are painted with white enamel or white zinc paint, they emit the most heat or, in other words, their capacity is raised; and those painted with aluminum bronze emit the least heat.

W. A. COURCHENE,
Boston, Mass. B. F. Sturtevant Co.

The Engineering Graduate

The product of the engineering colleges has been receiving of late through the correspondence columns of *Power* considerable adverse comment. Much of it has had to do with the college man's attitude while in and after he leaves college. Little has been said of his attitude before he enters college. Criticism seems to be expended on what goes on only, as it were, on the educational assembly floor. Why not go farther back?

To quote Premier Stanley Baldwin, who holds a man's job, "It is the education received unconsciously that counts for most in the making of a man." I take it he would include what goes to form attitude. Now what are some of the most important years for the male student in the forming of his attitude? Are not high-school years such? But what do we find? These high-school years that count among those that do most in the making of a man, are, by the vast majority of male students, spent under female teachers. And then we wonder at the attitude of our male students toward life and engineering and the amount of "education" that has to be undone in the shops.

The most prosperous nation on earth will not pay the price of high-school education for males in classrooms permeated with the male experience and viewpoint of life. At an age when formerly an apprentice boy at a trade would have charge of a number of laborers, our embryo professional engineers, except for a fortunate few, are imbibing views of life through the eyes of women. The blame, however, should not be laid to women.

And those who would turn to the state for more and more control of the individual will do well to ponder the foregoing situation. The state is a product of individuals. The salvation of a state rests with the individual. Men of means with the welfare of the state at heart will do well to provide means for taking out of the hands of women more and more of the preparation of youths for our colleges. In the meantime the interest of the boys in athletics, instead of menacing our educational system, is a healthy reaction against emasculated surroundings. But it cannot make good the loss of years away from contact with men capable of giving young males that attitude of mind which only the mature male can give, that vital portion of education "received unconsciously."

Detroit, Mich. ROBERTSON MATTHEWS.

Why do some engineers take such a delight in berating, belittling and criticizing the engineering graduate? Harmony is the basis of all successful institutions, and with the present effort to elevate the engineering profession in the public eye we must not lose sight of this fact. The engineering profession has been compared to law and medicine, and it is the aim of the engineers to elevate their profession to these standards. This can never be accomplished until the engineers realize that belittling one another does nothing save degrade the profession in the public eye.

The whole situation has a queer psychological trend. The great majority of men today under forty-five who hold responsible engineering and scientific executive positions are college graduates. This can readily be verified by personal observation, college alumni directories, college reunions at business men's conventions, and by the membership of the larger and more prominent clubs. The men who cannot see or will not admit that this is an age of successful young men are few indeed, yet these same men will go on berating the college graduate. I have been told by a man who has placed thousands of engineers in positions that it is not at all unusual for him to have a call for a recent graduate with four or five years' experience. How is the recent graduate, say twenty-two or twenty-three years old, who has spent eight years in grammer school, four in high school and four in college to have this experience? The whole situation savors of an unhealthy state of mind, a state of mind that smacks of destructive criticism, a tendency to tear down rather than to build up, a spirit that will not and cannot help to elevate the engineer in the public eye.

Nor is it quite fair to blame the engineer entirely. People generally seem to wish to talk on certain subjects that hold the spotlight at present, merely because it is the thing to do. We can readily understand and almost forgive H. G. Wells for attacking the colleges. He writes for the public what the public wish, but as engineers we cannot look on in silence as our fellow engineers berate the younger generation, simply because they think it is the thing to do. As long as we

do this, the engineering profession will remain in the realm where it now is.

Realizing the deficiencies of the engineering college, let us begin at this point and build upward so the engineering graduate of the future will be a better product, the engineer a better man and the engineering profession a profession in the true sense of the meaning; and above all let us not forget that criticism of the kind of engineering graduate has been subjected to by the engineers themselves is a destructive agency leading in one direction only—downward.

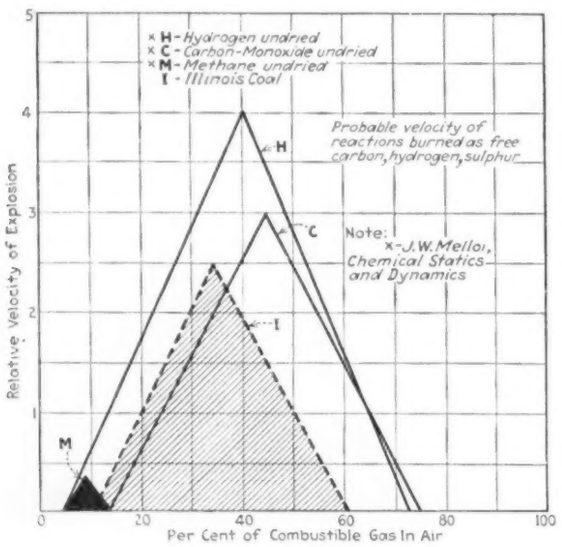
San Francisco, Calif. H. RICHARD AARON.

[Owing to space limitation it will be necessary to close the discussion of this subject with these two letters.—Editor.]

Why Short Flame Travel Reduces Furnace Volumes

The report of the International Conference on Bituminous Coal, which appeared in the Nov. 23 issue, contained some of the discussions, but did not include the practical data which the writer presented.

Concerning the discussion of water-cooled furnaces and heat liberation per unit of furnace volume, it has not been shown how water-cooled surfaces in furnaces tend to increase the heat liberation per unit of volume. Contrary results are obtained in practice. Combustion is retarded when the relation of water-cooled surface is in excess to the relative quantity of fuel burned.



The following list of pulverized-fuel installations and experiments would indicate that high rates of combustion or high heat liberation per unit of furnace volume are obtained in both refractory and water-cooled furnaces. It also indicates that there is not any relation between the heat liberation per unit of volume and the water-cooling surface. It does show that the heat liberation in a boiler furnace is dependent on the method in which coal is introduced into the furnace by either the long flame travel or short flame travel.

The duration of flame travel and completeness of combustion of bituminous coal is influenced by

1. Velocity of burning or explosion.
2. Temperature of combustion.
3. Air temperature.
4. Moisture content.
5. Amount of excess air.
6. Combustible mixture.
7. Oxygen content of air and fuel.
8. Shape and dimensions of ignition surfaces.
9. Shape and dimension of furnaces.
10. Shape and amount of water-cooling surface.
11. Catalytic agents, inert gases, etc.

This discussion is not intended to deal with the whole combustion problem, but rather, to cover the partial subject of velocity of combustion that controls the volumetric dimensions of furnaces.

With the long-flame travel coal is forced downward into the furnace by 10 or 20 per cent primary air, and 90 to 80 per cent of the secondary air is received along the path of flame travel, which produces a furnace condition similar to that of stoker firing where the combustion of coal takes place by partial combustion and distillation during the descending period, and by the final combustion of gaseous and other combustible rising toward the boiler.

The completeness of combustion of the gases depends on the velocity of explosion of such gases, as indicated on the chart, which determines the volume of furnaces.

The short flame travel, where all the coal, air, catalytic agents are introduced as a mixture, assures instantaneous ignition and complete combustion due to high velocity of explosion of gases, which explosion is further accelerated by the positive catalytic agents found in coal, such as water vapor.

The constituents found in bituminous coal, and as burned by the short-flame method, are carbon, hydrogen, sulphur, carbon monoxide with a negligible quantity of methane. The curves *H*, *C* and *I* are constituents which have the properties of increased velocity of explosion when in the presence of positive catalytic agents. Thus it would appear that the limitations of heat liberation per unit of furnace volume have been eliminated by the short-flame-travel method of burning pulverized fuel.

In the case of long-flame burning in the absence of sufficient oxygen to complete combustion, volatile matter distilled from bituminous coal leaves as complex hydrocarbon compounds, all of which are exothermic substances, not affected by positive catalytic agents, all

TABLE OF COMBUSTION RATES WITH REGARD TO FURNACE VOLUME

Station	Company	Operation: Rating (Normal)	Operation: Heat Lib. per Cu.Ft. per Hr.	Operation: Rating, (Maximum)	Operation: Heat Lib. per Cu.Ft. per Hr.	Type of Burners	Type of Furnace
Lake Shore	Cleveland Elec. Ill. Co.	167	8,000	300	15,000	Long flame travel	Water cooled
Trenton Channel	Detroit Edison Co.	210	10,470	380	19,300	Long flame travel	Water cooled
Comines	Ste. E. E. N.	182	24,400	...	.....	Short flame travel	Refractory
Western Ave.	P. S. P. & L. Co.	...	24,000	200	32,000	Short flame travel	Refractory
Warren, Ohio	Ohio P. S.	185	17,130	275	28,450	Short flame travel	Refractory
At Manchester, England	(Steam generator)	...	.....	...	40,000	Short flame travel	Water cooled
Canada Sugar Refinery Co., Montreal, Canada	(Burroughs boiler)	...	43,000	...	60,000	Short flame travel	Water cooled
Bettington boilers	.....	...	30,000	...	70,000	Short flame travel	Water cooled
Locomotives	.....	...	60,000	...	140,000	Short flame travel	Water cooled
Cannon furnace	Mass. Inst. Tech.	...	.....	...	225,000	Short flame travel	Refractory
Forge furnaces	.....	...	.....	...	330,000	Short flame travel	Refractory
Special furnaces	.....	...	.....	...	500,000	Short flame travel	Refractory

having low velocity of explosion. Consequently, extremely large furnace volumes are required for long flame burning.

A study of the accompanying chart, together with these data, should explain the fundamental principles that control the heat liberation in boiler furnaces, it being understood that furnace temperatures are to be maintained sufficiently high as found in practice.

Judging from the progress made during the year, one may expect both boilers and furnaces to be one-half their present dimensions for the same steam capacity in the near future.

J. GOULD COUTANT.

New York City.

The Derelict Engineer

At the beginning of his career the young engineer is confronted with the necessity of experience before he can demand remuneration greater than that of common labor. He practically apprentices himself to some concern to gain that experience. His employers probably consider him a liability at the beginning, but hope to develop him into material suitable for advancement into a position of responsibility. By the time he is thirty, his experience is such that he can command a fair salary but not enough to enjoy too many luxuries.

No doubt he has been promoted through continued service or by changes of position, which are not difficult during the period when his demands are low, and he feels that he is progressing satisfactorily. Perhaps he likes his work so well that he soothes himself for not receiving a greater salary with the thought that he has privileges to compensate for the difference between what he believes himself to be worth and what he actually gets. Then, too, he may have reached a point where his position gratifies his ego, and he believes that he is a man of importance, doing a man's work in the world. A few subordinates look to him as a superior being with unusual ability; they tremble when he commands and seek his favor; his associates marvel at his accomplishments; which all appeals to his vanity and soothes him marvelously.

He slips along until suddenly he realizes that he is forty or forty-five with but little in a material way to show for his years of theoretical preparation and experience. He becomes absolutely dissatisfied and looks around for an opening with another concern which he feels will appreciate his ability and reimburse him accordingly. He is assured that he need but make a few applications and choose from the best of the resulting offers.

Perhaps the situation is more urgent. Reorganization, internal politics or other causes have deprived him of his position. He frequents the employment offices where men of his class are enrolled, card indexed, and their records filed for reference. He scans the want ads of his trade magazines and often finds vacancies that he knows he can fill with satisfaction. He speaks to his friends and acquaintances of his desire to secure another position. They promise to remember him in the event that they learn of a vacancy. He makes personal calls on concerns that he thinks might be in need of such a man as himself. They listen politely and promise to advise him of any vacancies that may occur. He visits the employment agencies somewhat anxiously, and is told that nothing has developed in his line.

He continues to scan the want columns of trade papers and newspapers. He sends letters of application to the blind addresses as he has been doing for some time, but with no results, not even an acknowledgment of his application. He wonders if his references are treating him fairly and begins to doubt the value of his experience. He compares the class of men who are advertising for positions with the class of positions available. He observes that there is a surprisingly large number of experienced engineers and executives who seek positions; while in the columns of help wanted the predominating requirements are for machinists, draftsmen, electricians and other men skilled in manual crafts.

At this stage the conviction dawns upon him that there is so great a surplus of engineers that employers can demand men of exactly the experience suited to their specific requirements. He realizes that as an engi- he has become a specialist along lines that are either of no general value or the concerns that might be able to use him have been training young men to step into the positions that they find necessary to fill, and he is an outsider with expenses that require an income out of line with the kind of position that he may obtain.

The consequence is that generally he must accept a smaller salary and a smaller job, but an employer looks askance upon the older man who seeks the position. He questions his ability, temperament, habits and other characteristics and is a bit suspicious that there is something wrong with one of his age that he should be seeking a position.

There is a general prejudice against the older man. The age of forty seems to be the industrial deadline arbitrarily established regardless of the individual. A man is fortunate in having cultivated friends, who will speak a word for him where it will do the most good at this stage, for undoubtedly there are companies that are in need of men, and there is a better chance of locating through such recommendations, as he has the advantage of friendly representation without the disadvantages of open competition.

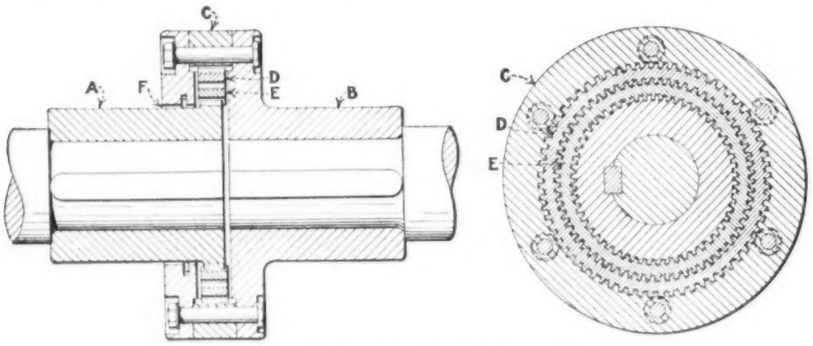
What can the experienced engineer seeking a position hope for aside from the chance assistance of friends, the employment department of his school or engineering society unless he possesses that rare talent among engineers called business ability and can start in some individual enterprise? The chief fault in the engineer's position is the fact that he has trained himself to be a mere hired man, unable to maintain himself as an individual, having no equity in the profits of his brain. His position is vicarious; he is a creative being harnessed to the requirements of industry that spews him out at will.

It would appear that corporations and other concerns find a man of value during but fifteen or twenty years of his life. After that he can be easily replaced, generally speaking; then he must be satisfied with a minor position or go on his own, especially if he has been so unfortunate as to permit himself to become one of the many specialists in lines of restricted possibilities.

Doubtless the engineer and his brother, the inventor, have done more to stimulate the progress of the world than any other agency known to man, but they have done it at a material sacrifice. How few names of inventors and engineers are being blazoned in the halls of fame during this age of industrial organization in comparison to the days of individual effort!

Moscow, Pa. A. SEARLES.

New and Improved Equipment



Longitudinal and cross-sectional views of coupling

Dahlstrand Flexible Coupling

The illustration shows a type of flexible coupling recently brought out by J. Y. Dahlstrand, Scio, N. Y. It consists of two hubs *A* and *B* keyed to the two shafts. The hub *A* has hobbed claws somewhat similar to gear teeth although not of a gear-tooth profile. The other hub *B* has bolted to it an internally hobbed member *C*, and two floating rings *D* and *E*, one of which is split in two, with claws on the inside and outside circumferences interposed radially between the hub *A* and the toothed member *C*. The whole assembly is tightly closed, and is lubricated by means of grease injected through a connection in the side of the coupling.

The coupling is made of steel throughout, thus allowing a high operating speed. It is free to move endwise to the extent of one-quarter inch without imposing any end thrust on either of the rotors, and is designed to permit of a considerable degree of angular misalignment and to have torsional flexibility. In the case of suddenly applied loads the film of lubricant between the various tooth surfaces acts as a cushion.

The coupling will also take care of a certain degree of lateral misalignment, in which case all the claws will not be engaged at one time, but since the claw surface is in excess of four times that necessary to transmit the load that can be carried by a certain shaft diameter, the coupling will transmit any loads imposed even with a considerable lateral misalignment. This is one of the several advantages claimed for this coupling.

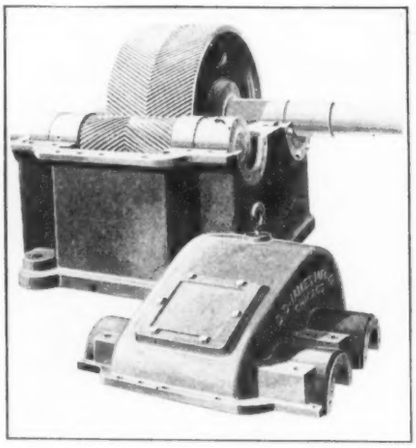
The alignment of the coupling is readily checked by measurement of the clearance at point *F* with a gage furnished with the coupling to assure that this clearance is the same around the entire shaft.

The coupling can be disconnected so as to allow operation of the prime mover without running the driven machine, or vice versa, as with duplex drives, without completely taking down the coupling. The only thing necessary is the unbolting of the cover and the removal of the inner split floating ring, which will entirely disengage the two coupled members.

James Herringbone Speed Reducers

The D. C. James Manufacturing Co., 1114 West Monroe St., Chicago, has developed a continuous-tooth herringbone gear for use in speed-reduction units. This type of gear embodies the double helical principle. Each tooth is brought to an apex and has the shape of a completed V. The tooth is not broken, and the apex is not rounded to provide for tool clearance.

The teeth are cut involute with a 20-deg. pressure angle and a 30-deg.



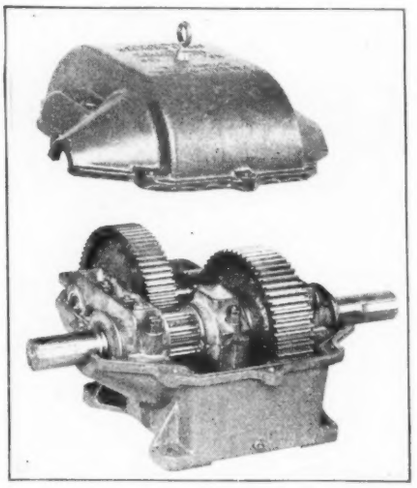
Herringbone-gear speed-reduction unit with cover removed

helix angle. The individual tooth is generated with a curve or twist so that the same profile is presented in the normal and to the diametrical planes of the gear. This design is made possible by a special gear generator. Owing to the continuous form of the teeth the end thrust is neutralized.

Reduction units with continuous-tooth herringbone gears, as illustrated, are being built in reduction ratios, ranging from 2 to 1 to 250 to 1 with capacities ranging from 2 to 200 hp.

Palmer-Bee Improved Speed Reducer

The Palmer-Bee Co., Detroit, Mich., has recently added to its line of speed reducers the improved mill-type unit illustrated herewith. In this unit spur gears are employed and the high- and



Improved spur-gear speed reducer

low-speed shafts are in line, a countershaft being used to obtain the reduction in speed. The bearings are exceptionally long, are cast integral with the bottom half of the casing and are bronze bushed. The gears are cut from forgings of special analysis steel or from electric steel castings, and the pinions are of high-carbon steel.

Referring to the illustration, it will be seen that the bearing caps are independent of the casing, so that the cover of the casing, which is split horizontally on the center line of the shaft, can be removed without disturbing the bearings.

All moving parts are lubricated by an oil bath splash and gravity feed system and are tightly inclosed in an oil-tight casing.

EVIDENCES OF CORROSION on the plates and seams of a boiler should be looked for constantly and diligently. They may be found both outside and inside. External corrosion is generally produced by leaks through riveted seams and by drippings from joints of piping. When leaks of this kind are discovered, they should be stopped without delay.

Lively Discussions on Pipe Welding Mark A. W. S. Meeting

MUCH of interest to power engineers was brought to light in a discussion of welded pipe lines by the New York Section of the American Welding Society on December 21. The scheduled speakers presented the subject from the viewpoint of exponents of three different welding processes—the metallic arc, carbon arc, and oxy-acetylene.

While all of the pipe lines described by the speakers are on public-service projects and hence lie technically in the field of civil engineering, much of the practical experience gained in laying such lines is of direct use to power-plant engineers. Brief abstracts will be given of the three papers and of the discussion.

Arc Welded Lines

A paper on arc-welded steel pipe lines in New York City was presented by William Schenstrom, welding engineer, Electric Welding Company of America. He said that the main advantages of electrically welded steel pipe lines for this work were great strength and elasticity. The early objection that steel pipe is quickly destroyed by corrosion has been largely removed, said Mr. Schenstrom, by the development of suitable protective coatings.

In New York City a 48-in. pipe made up of ½-in. flanged steel is being installed. It is lap welded in 20-ft. sections. Each section is in two courses. The pipe is rolled cold and given a 2-in. lap. It is held to exact size by internal expanders and external bands while this lap is welded. The welds are made slightly thicker than the plate on the longitudinal joints. The circumferential joints are of the sleeve type welded at each end of the sleeve and through holes in the sleeve. No welding is used on the pipe ends.

Mr. Schenstrom referred to an article in the December 2 issue of the *Engineering News-Record*, by Arthur P. Davis, chief engineer of the East Bay Municipal Utility District, California. In this Mr. Davis ascribed much of the trouble encountered when laying the 65-in. Mokelumne pipe line to internal stresses set up in the circumferential joints by the oxyacteylene welding operation.

Oxyacetylene Pipe Welding

Pipe welding from the oxyacetylene viewpoint was covered in a paper by LeRoy Edwards, industrial engineer, Air Reduction Sales Company. Not only is the welded joint much stronger than a riveted joint, said Mr. Edwards, but there is less friction loss and fewer leaks. Where leaks do occur, repair is much simpler than with screwed joints. Portability of the equipment is another big advantage. As compared with the cast-iron bell-and-spigot pipe line, the welded steel line avoids the need for special foundations. It has no pockets for sediment and is flexible enough to follow the contour of the ground.

Mr. Edwards said it was the custom of the shop with which he is connected to make as many standard fittings as possible in the shop to keep all good men on the payroll in slack seasons. All these are made in accordance with standard charts. The shop keeps a full stock of cast-iron templets for marking and cutting. In the matter of personnel Mr. Edwards felt that every welding firm should have one or more boss welders capable of selecting, testing and training men.

No expansion joints are ordinarily needed, Mr. Edwards pointed out, in the case of long cold-water lines following a sinuous course. However, straight lines or steam lines must be provided with expansion joints or bends.

Fabricating 65-in. Line

A paper prepared on "Welding of Pipe Lines for the Mokelumne River Project," by J. F. Lincoln, vice-president of the Lincoln Electric Co., was read by Mr. Bull. It discussed the use of electric welding in the shop fabrication of the 65-in. diameter sections for this large water-works job.

After the steel sheets were delivered to the fabricating shop, the edges were planed and then turned in breaking rolls, after which they were shaped to half-cylinders by bending rolls. The sheets were then put in a jig and tack welded, after which the longitudinal seams were completed by an arc welding machine. The plates range from ¼ to ¾ in. in thickness. The penetration was said to be complete even with the thickest place, although the welding was done from the outside only and the plates were butted together without V-notching. The sections were tested by applying a hydrostatic pressure slightly less than the elastic limit and hammering the weld with 19-lb. sledges.

Cast-Iron Templets

In the discussion Mr. Edwards said he used cast-iron templets instead of those made from sheet steel, because the former withstood the cutting torch, and also because they were thick enough to indicate bevel as well as contour.

It was pointed out by E. Vom Steeg, of the General Electric Co., that where pitting occurs by corrosion on the outside, repairs are much easier with steel pipe than with cast-iron. Even where a small hole penetrates a high-pressure water line, a repair can be made without shutting down the line by driving a pine plug into the hole, cutting it off and welding over.

The description of the arc-welding shop fabrication for the Mokelumne project by Mr. Lincoln together with previous mention by Mr. Schenstrom of failure of circumferential gas-welded joints on the same job led to a rather lengthy discussion, in which G. O. Carter, of the Linde Air Products Co., and H. J. Grow, of the Air Reduction Sales Co. disagreed with the conclusions reached by Arthur P. Davis, chief engineer on this job.

Mokelumne Engineering Under Fire

Referring to Mr. Schenstrom's remarks on internal strains set up by temperature differences along a circumferential weld, Mr. Carter said that thousands of miles of gas-welded pipe had been installed without trouble and at very low labor cost. He saw no need for the sleeves used by Mr. Schenstrom on the New York City job and said a plain butt weld was satisfactory with gas. The procedure on the Mokelumne job, said Mr. Carter, was entirely wrong. He cited the case of a rotating kiln 8 ft. in diameter and of 75 ft. span, where a circumferential weld subjected to continual reversal of stresses had stood up for quite a long time.

In a lengthy discussion Harold Grow, of the Air Reduction Sales Co., criticized the Mokelumne job very severely from an engineering viewpoint. The specifications, he said, were faulty, as was the procedure in laying the line. He produced a section of weld to show that the welds themselves were of good quality. In view of the fact that some of the welds opened as much as four inches, he did not see how the trouble could be ascribed to internal strains.

Back Filling as Preventitive

The most serious omission, in Mr. Grow's opinion, was failure to provide against excessive expansion and contraction of the whole line, in a climate where an exposed pipe will fall from 140 deg. in the day time to 32 deg. at night. He said that back filling with dirt as the line was laid would have kept temperatures uniform and have eliminated this difficulty.

It is impossible for lack of space to bring out many of the points made by Mr. Grow, but it should be pointed out that his discussion was a very severe arraignment of the job from an engineering point of view, considered with high professional stands.

In closing the meeting, the Chairman, F. E. Rogers, said that it was greatly to be regretted that the engineers on this job did not know more about welding. He felt that the educational work of the American Welding Society could do much to prevent such fiascoes, due to impossible specifications.

Recent Publications

Combustibles Inferieurs et de Remplacement (Inferior and Substitute Fuels). By Pierre Appell. Published by Gauthier-Villars & Cie., 55, Quai des Grands Augustins, Paris, France, 1926. Paper, 190 pages, 45 illustrations. Price, 20 francs. Foreign postage, 2.50 francs.

This book reviews French and other foreign practice in the utilization of such fuels as wood, charcoal, coke and waste products of mining, industrial processes and agriculture. Boiler settings are shown for these various fuels. Economic and combustion data are included.

The Practice of Lubrication. By T. C. Thomsen. Second Edition. Published by McGraw-Hill Book Co., Inc., New York City. Cloth; 6x9; 616 pages; 277 illustrations. Price, $6.

The announcement in 1920 that a book on lubrication by an engineer of the standing of T. C. Thomsen was received with acclaim by engineers. The science of lubrication had heretofore been so clothed in mystery that the average man felt that in all probability even the oil men knew but little of the facts involved. The author went into lubrication so far as its application was involved and did much to educate the power-plant force in methods of better lubrication. In the second edition, just off the press, the author has somewhat increased the scope of treatment and has included developments that have taken place during the last six years. This is one volume that should be on the book shelf of every engineer.

Arc Welding—The New Age in Iron and Steel. Published by the Lincoln Electric Company, Cleveland, Ohio, 1926. Imitation leather; 6x9 in.; 159 pages; 236 illustrations including charts; numerous tables. Price $1.50.

The circumstance that this book is published by a manufacturer of arc-welding equipment should not obscure the fact that it is an important contribution to engineering literature. As implied in the title, the full application of welding will mark a new age in iron and steel. It is not merely a question of the technique and cost of making good joints by welding, important as these are. Of greater significance is a point of view that must extend back into the drafting room and free the designer of his preconceived notions as to proper shapes and materials. Machines must be designed for welding from the ground up if the greatest economies of this method of fabrication are to be realized. As pointed out in this book, the two chief objectives of welding are the elimination of riveted joints and the replacement of cast-iron parts by steel. In the first of these fields welding is already widely used by tank manufacturers and is getting a start in the structural steel field. Steel is not only much stronger than cast iron (particularly in tension and bending) but also much stiffer and cheaper. Hence the use of fabricated steel frames, bases and other machine parts produces a double saving, since less metal is needed and that used costs less per pound. The application of these principles by some of the more progressive manufacturers is shown by many examples with photographs and comparative cost figures. Examples given of welded jobs in the power field include motors, machine bases, fans, receivers, piping, tanks, guards, heating boilers, air heaters, hoppers and bunkers, conveyor buckets, coal buckets, stacks, etc. The wealth of practical information in this book will make it indispensable to the engineer interested in the use of welding to reduce construction costs.

Patents. By Roger Sherman Hoar. Published by The Ronald Press Co., New York. Cloth; 6x8½ in.; 232 pages. Price, $4.50.

This book is intended to be, not so much a treatise on patent law as on patent tactics. It translates into plain English so much of the patent law as the business executive or the inventor needs to know to enable him to cooperate intelligently with his attorney. Most of the popular conceptions of patents are shown to be erroneous. The subject is discussed with a delightful clarity of style and with the use of simple illustrative situations that help the reader to grasp the author's meaning. The need for such a book is widespread. To take the simplest example, many inventors are under the impression that a patent is a license to manufacture. It will come as a shock to them that this is by no means the case. Even if the patent proves to be entirely sound and valid it is nothing more than a license to stop anybody else from manufacturing the article patented. This is generally the case with a patent which is merely an improvement on something else. The man who patents the improvement generally cannot manufacture it himself without infringing the patent on the original article. He can keep the original patentee from manufacturing the improved article and thus put himself in a position to negotiate for royalties or sale of his patent.

The book should be read by business executives who are responsible for the protection of their firm's products and by inventors who contemplate securing patents. Any intelligent person can understand it, and those who have not studied the matter before need it.

Water Resources Paper No. 49. The Dominion Water-Power and Reclamation Service of the Interior of Canada has published a new volume of that portion of the series of water resources papers which deals with the surface-water supply of Canada. This report is number 49 of the series and gives details of stream measurements made in the province of Ontario during the climatic year from Oct. 1, 1923, to Sept. 30, 1925. The Reclamation Service of the Department of the Interior is engaged in making a systematic survey of the water resources of the whole of the Dominion. For convenience in the administration of a survey covering so great an area, the country is divided into four major districts, whose boundaries are arranged to correspond as far as possible with the watersheds dividing the great river systems of the northern part of the continent. The report under review is one of the second series, a companion report for Quebec being No. 48. It contains a short explanation of the purpose and scope of the work and 110 pages of tables and descriptions of gaging stations, with an index map of Ontario showing their location. This report will be supplied free of charge on application to the Director, Water Power and Reclamation Service, Ottawa, Canada.

The Newcomen Society for the Study of the History of Engineering and Technology. Transaction, Volume IV, 1923-1924. London: The Courier Press, Leamington Spa. Cloth, 150 pages, 21 plates, index of cross reference.

This distinguishedly prepared volume of transactions of the Newcomen Society presents in full and handsome form the activities of that body for the year 1923-24 introduced by the presidential address by Loughnan St.L Pendred, M.I.Mech.E., delivered at Prince Henry's Room, Fleet Street, E.C., Oct. 26, 1923, on "The Value of Technical History." A scholarly dissertation on the "Dynamics of Leonardo da Vinci," by Ivor B. Hart, O.B.E., Ph.D., B.Sc., A.F.R., AeS., as delivered at Caxton Hall, Westminster, Dec. 6, 1923, illustrated with many figures from da Vinci's notes and with an introductory note on the manuscripts, is of unusual interest to the historian. Attention is called to a chain pump dredger of the sixteenth centry by G. E. Zimmer, A.M.Inst.C.E. Other discourses on early European devices include "A Chain of Pots of the 6th to 7th Century A.D.," by the same author; "A 16th Century Tread Wheel for Raising Water," by H. A. Sandford, M.A., F.G.S.; notes on Evelyn's "Circle of Mechanical Trades," 1661, by A. Forbes Sievekig, F.S.A., F.R.Hist.S.; "The Rastricks: Civil Engineers," by H. W. Dickinson and A. Lee; "The Four Locomotives Imported into America in 1829 by the Delaware and Hudson Co.," by L. F. Loree, M.Sc.; "Works Organization in the Seventeenth Century with Some Account of Ambrose and John Crowley," by W. A. Young; "A Sketch of the Industrial History of the Coalbrookdale District," by Rhys Jenkins, M.I.Mech.E., who also contributes "Savery, Newcomen and the Early History of the Steam Engine, Part II." Notes and communications include a report of the summer meeting of 1924, "A Link with Newcomen" and "In Memory Trevithick." An analytical bibliography of the history of engineering, the annual report, and statement of accounts and a list of members completes the volume.

News in the Field of Power

Prominent Engineers and Industrialists Gather To Honor James H. McGraw

Birthday of Technical Publisher Celebrated at Testimonial Dinner Marks Forty-one Years of Service—1,000 Attend

MARKING the forty-one years of service to the engineering and industrial progress of the country, and incidentally the sixty-sixth birthday of the guest of honor, over one thousand of the leaders in business, industry and science gathered at the Hotel Astor, New York, on Dec. 17, as a testimonial to James H. McGraw, president of the McGraw-Hill Publishing Company, Inc., the largest publisher of technical and business magazines and books in the world.

The speakers represented some of the fields covered by McGraw-Hill publications, in which Mr. McGraw has long been an important factor. General Tripp spoke as the representative of the electrical manufacturing industry; Dean Dexter S. Kimball of the Cornell University School of Engineering, spoke on behalf of engineering; Charles L. Edgar, president of the Edison Electric Illuminating Co., of Boston, for the power industry; and Willits B. Sawyer, president of the American Electric Railway Association, for the electric railway industry. John W. Lieb, vice-president and general manager of the New York Edison Co., acted as toastmaster.

Service to Engineering

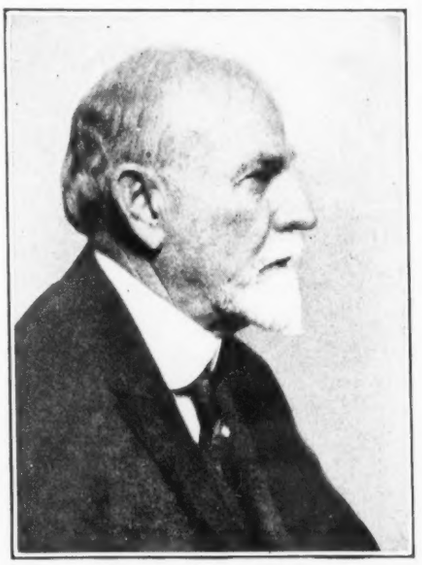
Dean Dexter S. Kimball, of Cornell University, spoke on behalf of the engineering profession. He sketched briefly the development of engineering and science in this country.

Spoken words may disappear and these words do disappear, but the written word remains a heritage for all succeeding generations, was the keynote of Dexter S. Kimball's address on Mr. McGraw's influence in the development and progress of the world of engineering.

"A few years ago, a comparatively few years ago, almost in the memory of men sitting before me, we began to gather recorded experience in this field from which has come agriculture, mechanical arts, and this thing we call engineering. In an amazingly short time, we rolled up a fund of knowledge, the like of which the world has never seen. To those of us who live on a college campus and have seen this thing grow for twenty-five or thirty years, it is surprising and interesting. No thinking man, and especially a man interested in engineering work, will doubt that this thing of which we speak, this recording of experience, this discovery of facts, lies at the very bottom of our modern prosperity, at the very root of this great nation, and has been instrumental in raising it to a position unique, not only among the nations of today, but among all the nations that have ever existed."

Value of Recorded Word

"That is the growth that I would like to call your attention to in technical



James H. McGraw

literature today. That is the kind of a background against which I wish to place our honored guest, the one great thing that has come to us then, the art of recording experience and using it so that those who come after us will be assured that they can continue this great civilization. First, we have solved this problem of production, and second we have builded a platform from which we can surely carry this on."

"I might say many things of Mr. McGraw's qualities, but I think enough has been said and others will say more. However, I would again emphasize what has been said, that possibly no enterprise has ever been so influential, no enterprise for recording scientific and engineering experience, no enterprise so great has ever been built, and I do not know of any that has been so well directed from the idealists' standpoint, and I speak from a long experience with both branches of McGraw-Hill."

Willits B. Sawyer, president of the American Electric Railway Association, reviewed the growth of urban transportation and paid tribute to service rendered to this growth by Mr. McGraw and his publications. The co-operation of Mr. McGraw's organization and his magazines, and Mr. McGraw personally, had been of inestimable value to the electric railway industry in the years during which it has faced its most serious problems, said Mr. Sawyer.

Charles L. Edgar, president of the Edison Electric Illuminating Co., of Boston, dwelt on the value of co-operative effort and brought out the effort that Mr. McGraw has put forth in furthering co-operation in the electric industry. He differentiated between Mr. McGraw's desire to help, and just the ordinary willingness. On the subject of journalism, Mr. Edgar said that the McGraw-Hill publications represented what was the best in journalistic effort. He said that Mr. McGraw had the happy faculty of making the chiefs of industry work for his papers.

The electric manufacturing industry was represented by Gen. Guy E. Tripp, chairman of the board of the Westinghouse Electric and Manufacturing Co. General Tripp spoke of the high qualities of Mr. McGraw and paid great tribute to him as a friend, a business man and a part of the country's industrial life.

Suggests New Publication

General Tripp expressed the wish that the public might have a sounder conception of public utilities and suggested that Mr. McGraw add another publication to his already long list and devote it entirely to the sociology of business.

"I think you might be able to discover a philosophy in it which the rest of us have been too busy to find for ourselves," said General Tripp. "But, whether you do it or not, we still appreciate the great service which you have already rendered industry and thank you sincerely for it."

Outlines Guiding Principles

The last speaker was Edward J. Mehren, vice-president of the McGraw-Hill company, representing the publishing industry. He outlined the business principles of Mr. McGraw which are found exemplified in his many publications. He said that an ardent spirit of service, of faith, vision, courage and perseverance were the qualities which Mr. McGraw has brought to bear on his work and the work of his organization. Mr. Mehren concluded with this tribute to his chief:

"That he might build an institution that could valiantly serve engineering and industry, that could help lead them to higher ideals and greater effectiveness, that could help solve their baffling problems, that could make them better agencies for engineers, owners, managers, employees and the general pub-

lic whom, in the last analysis, we all serve—such has been his ambition, such has been his very life."

MR. MCGRAW'S RESPONSE

Responding to the call of the toastmaster, Mr. McGraw thanked his audience for the tribute paid him, but insisted that the leaders of industry who so honored him were themselves worthy of commendation, for without their co-operation his efforts would not have borne fruit.

"It is beyond me to express my appreciation of this tribute of affection and good will," said Mr. McGraw.

"That there has been a certain accomplishment your tribute forces me to admit. I wish that the accomplishment might have been larger and that the service rendered to you, your professions, and your industries might have been even more intimate and effectual. But whatever the accomplishment, it would not have been possible without the ardent co-operation of two important groups:

"The first of these consists of my own loyal and competent associates in the McGraw-Hill Publishing Co., the McGraw-Hill Book Co., and their subsidiary organizations.

"The second group which has been essential to whatever accomplishment there has been, is composed in their entirety of the professions and industries which you represent. It has always been my thought that our publishing enterprises, both magazines and books, have been an intimate part of the professions and industries.

GRATITUDE TO ENGINEERS

"A great satisfaction that I take out of this evening's meeting is, that it gives me an unusual opportunity to express in this public way my gratitude to the engineers and industrialists of America for the parts they have played in making possible McGraw-Hill magazines and McGraw-Hill books. Without you, our work could not have been done. Without you, our institutions could not have existed. I thank you heartily for your help, and believing as I do that our institution can be of still larger service, I pray your co-operation for the future.

"We have never wanted to stand alone in any effort if other agencies could help, nor did it matter whether we or someone else originated the idea. Our part would be played as vigorously in the one case as in the other. We have, therefore, co-operated with all agencies which have worked in a forward-looking attitude for the advancement of the engineering profession and industry; we have co-operated with the engineering societies, national and local, with trade and industrial associations of every kind; with government agencies; with research bureaus."

On his association with men in industry, Mr. McGraw said that the engineers and industrialists with whom he had worked had remade the physical conditions of the civilized world in these 40 years. "To work with you, and the thousands of your fellows whom you represent tonight, has been a source of constant inspiration," he said. "To serve you, to help you in your developments in engineering and industry has been an inestimable privilege."

"For the privilege of having served in this ministry," Mr. McGraw concluded, "I have you to thank, for your co-operation has made it possible. With all my heart I thank you for the privilege. With all my heart I thank you for your tribute this evening."

THOSE ON DINNER COMMITTEE

During the course of the dinner many telegrams were received from some of the guests who were unable to be present.

The committee that sponsored the dinner included Thomas A. Edison, as honorary chairman; Secretary of Commerce Herbert Hoover; Gen. Guy E. Tripp, chairman of the board of the Westinghouse Electric and Manufacturing Co.; Gerard Swope, president of the General Electric Co., and Owen D. Young, chairman of the board of the General Electric Co. Others on the committee were J. J. Carty, vice-president, the American Telephone and Telegraph Co.; Simon Guggenheim; John Hays Hammond; William Barclay Parsons; George Otis Smith, director of the U. S. Geological Survey; Sidney Z. Mitchell; Fred R. Low, editor of *Power;* Samuel Insull; Adolph S. Ochs; William T. Dewart; Karl A. Bickel; Dr. Livingston Farrand, president of Cornell University, and Nicholas F. Brady. Arthur Williams, vice-president of the New York Edison Co., was chairman.

Oil Power Conference of 1927 To Award Diesel Prize

Announcement has been made by the Oil Power National Conference of 1927, conducting the coming year's Oil and Gas Power Week, that over fifty meetings have been definitely scheduled for sessions to be held April 18 to 20.

A prize of $100, to be known as the Rudolph Diesel Award, has been instituted and will be given for the best paper on oil engines presented at any of the several hundred meetings held during that week.

"Because of the many points of contact between oil engine and technical men," it was emphasized by Edgar J. Kates, chairman of the national committee meeting, "it is fitting that the national technical societies of the country should have joined in an educational movement to bring to general attention all available information concerning the oil engine and to indicate the directions for further progress."

This co-operative effort will in 1927 be carried on under the sponsorship of the American Society of Mechanical Engineers, American Chemical Society, Local Sections, National Association of Stationary Engineers, National Association of Practical Refrigerating Engineers and the American Society of Naval Engineers.

The object of the conference is to focus, during the week, nation-wide attention on recent progress and on future possibilities in the production of power by the use of oil in internal-combustion engines. This will be accomplished by holding numerous meetings throughout the country. These meetings will be conducted by the local sections of the participating national societies.

During the last two annual conferences, over 200 meetings were held in 33 states, the attendance being about 21,000, and present indications are that twice this number will be held in 1927.

Northern States Power Plans Chippewa River Project

Early construction of an important water power development at Chippewa Falls on the Chippewa River by the Northern States Power Co. has been announced by H. M. Byllesby & Co. providing action of the Chippewa Falls city council, which has voted to annul proceedings to purchase the electric distribution system in Chippewa Falls from Northern States Power Co., is not disturbed.

The Chippewa Falls plant, which will be built under the supervision of Byllesby Engineering & Management Corp., will have a capacity of 24,000 hp. in 6 units of 4,000 hp. each. This project, it is estimated, will cost about $2,600,000.

The dam and power house will be located about two miles below the present hydro-electric development at Wissota, which has a capacity of 45,000 hp. It will utilize existing storage facilities created by the Wissota development, operating synchronously with Wissota, and will be tied in with the extensive transmission system of Northern States Power Co. in Wisconsin and Minnesota.

The Chippewa Falls development will operate under a head of 30 feet. It is planned to begin construction work next year.

Japan Proposes Unification of Electricity Supply

The Japanese government has decided to finance a commission to investigate all matters connected with the desirability and methods of unifying the electrical power of the country. Hydro-electric power has been developed so greatly that in point of capital invested it is now one of the largest industries in Japan.

When the projects now under construction are completed, the difficulty of distributing the available power under a competitive system will become a serious one. Plans by which the entire system of electric production and supply may be unified under some form of government control are under consideration, and the commission will study all phases of the problem and present a report, according to news from Tokio.

To Erect Four Power Plants In Iceland

A Norwegian electric power company is planning the erection of six power stations in Iceland, according to a report from the Consulate General at Oslo, Norway. The total capacity will amount to 900,000 horsepower.

New Jersey Power Company To Push Construction

Completion of the recapitalization program of the New Jersey Power & Light Co. recently approved by the public service commission of New Jersey, was announced Dec. 19 with the sale to Halsey, Stuart & Co. of $6,000,000 first mortgage 5 per cent. bonds, due Aug. 1, 1956. Public offering of the bonds will probably be made shortly.

In addition to the recapitalization, a part of the funds will be used in the construction program of the company. A new 110,000-volt substation, which is an important link in the superpower system of that part of the country was recently completed at West Wharton, N. J., and construction will soon be started upon the first 30,000-kw. unit of a new generating station at Holland, N. J., on the Delaware River. This station will have an ultimate capacity of 200,000 kw.

In addition, the company is steadily extending its facilities to care for the increase in its customers and output which has been rapid in recent years, the kilowatt-hour sales have increased 366 per cent and the electric customers 702 per cent in the period from 1917 to 1925.

Its continuance of this growth during the present year is indicated by the fact that it had 26,117 electric customers on Oct. 31, 1926, compared with 21,156 customers on Dec. 31, 1925.

Clyde River Power Company Sold for $500,000

The Clyde River Power Co. of Richford, Va., which has been in the hands of a receiver for two years, has been sold to John J. Flynn of Burlington, president of the Burlington Traction Co. The price was $500,000.

The property includes a water power at Richford and a fifty-mile power line from that point to Island Pond. It is estimated that $1,000,000 has been invested in the company, mostly by residents of Maine and Vermont.

Merger with Georgia Power Company Gets Approval

Preferred and common stockholders of the Georgia Railway & Electric Co. have approved merging with the Georgia Power Co., a subsidiary of the Southeastern Power & Light Company.

Other properties involved in the merger are the East Georgia Power Co., Athens Railway & Electric Co. and Rome Railway & Light Company.

Potomac Edison Cuts Power Rates in Four States

The Potomac Edison Co., with headquarters at Hagerstown, Md. has filed a new schedule of rates, marking a reduction up to 40 per cent in the various blocks of domestic electricity.

A saving of about $75,000 annually to consumers in Pennsylvania, Maryland, West Virginia and Virginia will result. Cities affected are Cumberland and Frederick, Md.; Waynesboro, Pa.; Martinsburg, W. Va.; Winchester, Va., and the towns in proximity to them.

The reduction is the first move by a subsidiary of the American Water Works Co. to induce the public to increase the use of electricity, and is expectd to accelerate the vast trade in electrical appliances.

A contract has been let by the Potomac Edison Co. for a large addition to its $2,000,000 power plant at Williamsport, Pa., and completion of this addition next year, it is announced, will triple the capacity of that plant.

Six New York Power Concerns Form Consolidation

The consolidation of six power companies into the Central Hudson Gas & Electric Corp. was approved Dec. 16 according to an order issued by the New York Public Service Commission. The new corporation will officially come into being about January 1.

The companies concerned in the consolidation were the United Hudson Gas & Electric Co., the Kingston Gas & Electric Co., the Upper Hudson Electric & Railroad Co., the Ulster Light, Heat & Power Co., the Dutchess Light, Heat & Power Co. of Rhinebeck and the Central Hudson Gas & Electric Co.

Officials of the new corporation say there will be no change in the management of the respective companies.

Power Station Dons Seemly Garb as Bungalow

The new Rockford-Manito substation of the Washington Water Power Co., at Twenty-fifth and Arthur Sts., Spokane, Wash., built after a bungalow plan followed by some California power companies, was placed in commission Dec. 15.

The building architecturally fits into a residental district and the power lines are so arranged as not to be too noticeable. The station is equipped with one 1,000-kw. transformer with a capacity for a second one later when the needs of the district call for it.

The purpose of the substation is to improve the residential service of the district and afford ample power for future growth. Other sections of the city will probably be served in the same way as the light and power load increases.

Obituary

Charles E. Squires, president and treasurer of the C. E. Squires Co., manufacturers of steam specialties, Cleveland, Ohio, died Dec. 9 at the age of 62. Mr. Squires was born Sept. 5, 1864, in Bayport, Michigan. He removed to Cleveland when he was eighteen years old and worked as a steamfitter. As a result of application and initiative he invented the Squires boiler feed water controller, three types of pump governors, reducing valve and the three Genuine Squires steam traps. He incorporated the concern manufacturing his products in 1904 under the head of The C. E. Squires Co., of which he was president and treasurer.

Personal Mention

Lisle A. Pierson, formerly with the Connecticut Light & Power Co., Devon, Conn., plant, has accepted the position as chief engineer of the power plant of Frederick Stearns & Co., Detroit, Mich.

G. K. Saurcein, formerly assistant engineer with the Electric Bond & Share Co., has recently become power engineer with the Semet Solvay Co., with his headquarters in the New York office of the firm.

Dr. W. A. Taylor, president and chemical director of the LaMotte Chemical Products Co., addressed the Maryland Section of the American Chemical Society on December 17. The subject of his talk was "Hydrogen Ions in Industry."

Edwin H. Brown has been appointed assistant manager of the steam turbine department of the Allis-Chalmers Manufacturing Co. For some years Mr. Brown has held the position of engineer in the same department, of which A. C. Flory remains the manager.

R. L. Stanton, a graduate of the University of Pennsylvania, 1914, who has had experience on substation and power-plant design, railway computations and power studies, has been engaged as an application engineer in the blower section of the American Brown Boveri Electric Corp.

Frank T. Horan, who recently entered the drafting department of the American Brown Boveri Electric Corp., after 11 years' experience with the General Electric Co. at Schenectady, N. Y., where he specialized on A.C. motors and generators, electric furnaces and switchboard equipment, is now detailed on oil circuit breakers in the design section of the electro-mechanical division.

Frederick M. Feiker, who for 15 years was editor and publisher of industrial journals, has been appointed managing director of the Associated Business Papers, Inc., with headquarters at 52 Vanderbilt Avenue, N. Y. In 1915 Mr. Feiker served with the McGraw Publishing Co. as editor of the *Electrical World* and guided the early development of *Electrical Merchandising*, becoming vice-president and editorial director of the McGraw-Hill Publishing Co.

Business Notes

The Chain Belt Co. has appointed W. H. Brandt, advertising manager, to the position of assistant secretary, succeeding George M. Dyke, who has gone to Cleveland to assume the duties of

secretary of the Stearns Conveyor Co., which is now owned by Chain Belt Company. A. R. Abelt is now advertising manager.

The Chicago Pneumatic Tool Co. announces that it is marketing a line of new vertical four-stroke-cycle gas-engine-driven air compressors of standard air pressure for commercial purposes, and high-pressure two-stage compression for the flowing of oil wells. They are designated as types V-CTG and V-CTGZ.

The Johns-Pratt Co., manufacturer of sheet packing and more recently the pioneer developer of such electrical protective devices as meter service switches, fuses, service boxes and high-voltage underground equipment, has been taken over by Colt's Patent Fire Arms Manufacturing Co. The control of the Johns-Pratt Co. has, for a few years past, rested in the Colt's Patent Fire Arms Manufacturing Co., and its activities carried on as a division of the controlling organization. Recently the Colt board of directors took over the Johns-Pratt Co. completely.

The Electric Controller & Manufacturing Co., of Cleveland, Ohio, announces a new rotating cam limit switch to be used with magnetic controllers for the automatic control of machines having such fixed sequence of operation as slowing down, stopping and reversing. This cam type limit switch is totally inclosed, is equipped with tapered roller bearings and is designed to carry up to six sets of contacts. The cams which operate the opening and closing of the contacts, are each adjusted independently of the others and can be fixed at an infinite number of positions, thus giving extreme flexibility to the machine with which they are used.

The Gatineau Power Corp. has appointed Rupert F. Howard, until quite recently identified with the Power Corporation of Canada, as manager of power sales. Mr. Howard served his apprenticeship in the East Pittsburgh shops of the Westinghouse Electric & Manufacturing Co., later entering the engineering office and then the construction department. When the Canadian Westinghouse Co. was organized he was transferred to Montreal as district engineer. He later became manager of the Winnipeg office of the Canadian Westinghouse Co. and resigned to take up the duties of the chief electrical engineer of the British American Nickel Corporation at Ottawa, later returning to Montreal to engage in private practice.

Trade Catalogs

Babbitt Metal—The Hoyt Metal Co., St. Louis, Mo. This small booklet will be very valuable to users of babbitt metal. The designing of babbitt bearings, casting of the babbitt, casting and fitting the bearing are among the topics considered.

Multiport Valves—The Cochrane Corp,. Philadelphia, Pa., in publication No. 1381 takes up Cochrane multiport valves for steam, back pressure, atmospheric relief, flow and check valve service; for water check valve service, and for air and gases, relief and check valve service.

Coming Conventions

American Association for the Advancement of Science. Annual meeting at Philadelphia, Dec. 27-Jan. 1; Burton Livingston, Secretary, Smithsonian Institution Bldg., Washington, D. C.

American Engineering Council. Annual meeting at Washington, D. C., Jan. 13-15. L. W. Wallace, 24 Jackson Place, Washington, D. C.

American Institute of Electrical Engineers. Winter convention at New York City, Feb. 7-10; F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Society of Heating and Ventilating Engineers. Annual meeting at St. Louis, Mo., Jan. 25-28; A. V. Hutchinson, secretary, 29 West 39th St., New York City.

Chicago Power Show, at Chicago, Feb. 15-19. G. E. Pfisterer, managing director, 53 West Jackson Blvd., Chicago.

Engineering Institute of Canada. Richard John Durley, secretary, 176 Mansfield St., Montreal, Que. The forty-first annual general and general professional meeting will be held at Montreal on Thursday, Jan. 27, and will be adjourned to reconvene at Quebec City at the Chateau Frontenac Hotel Feb. 15, continuing on the two succeeding days.

Midwest Power Conference, at Chicago, Feb. 15-18. Sessions will be held in the Coliseum concurrently with the Chicago Power Show; G. E. Pfisterer, secretary.

National Association of Stationary Engineers. New England States convention at Portland, Me., June 17-18. Thomas H. Clark, president, Worcester, Mass.; Robert Johnson, secretary, 65 Charlotte St., Worcester, Mass.

National Electric Light Association. A. Jackson Marshall, secretary, 29 West 39th St., New York City. Annual convention at Atlantic City, week beginning June 6.

National Marine Engineers' Beneficial Association. Fifty-second annual convention at the Hotel Franklin Square, Washington, D. C., Feb. 14. Albert L. Jones, secretary-treasurer.

Expansion Joints—Henry Pratt Co., Chicago, Ill. Bulletin J-4 is devoted to Philips expansion joints, which give flexible connection between the exhaust flange of a steam turbine and its condenser, or in other low-pressure pipe connections where flexibility, tightness and simplicity are essential.

Automatic Gas Analysis Indicators and Recorders.—The C. J. Tagliabue Manufacturing Co., 18-88 33rd St., Brooklyn, N. Y. Bulletin 932 describing the new TAG Mono Duplex automatic indicator-recorder for analyzing CO_2 and CO. This instrument is the fruit of experience with the model which it supersedes, and embodies in practical combination some new features and conveniences which had been demanded by power plant engineers. Some of its features, conveniences and improvements are unique. The Mono operating principle is retained.

Filters—Cochrane bulletin No. 673, published by the Cochrane Corp., Philadelphia, Pa., treats of the clarification of water by filtration, and discusses the Cochrane strainerless conical filter. The design and application of the Cochrane single control valve, the Cochrane flow rate controller, Cochrane filter with self-freeing strainer heads, the Cochrane Junior filter, and multiple filters are described and illustrated by many figures and sectional views.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	Dec. 13 1926
Pool 1	New York	$3.75@$4.00
Smokeless	Boston	3.10
Clearfield	Boston	2.40@ 2.90
Somerset	Boston	2.50@ 3.10
Kanawha	Columbus	2.00@ 2.25
Hocking	Columbus	1.90@ 2.25
Pittsburgh	Pittsburgh	2.00@ 2.25
Pittsburgh gas slack	Pittsburgh	1.90@ 2.00
Franklin, Ill.	Chicago	2.75@ 3.00
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.50@ 2.75
West Ky.	Louisville	1.25@ 2.00
S. E. Ky.	Louisville	1.75@ 2.50
Big Seam	Birmingham	2.00@ 2.25
Anthracite Gross Tons		
Buckwheat No. 1	New York	2.25@ 3.50
Buckwheat No. 1	Philadelphia	2.40@ 3.00
Birdseye	New York	1.40@ 2.00

FUEL OIL

New York—Dec. 22, light oil, tank-car lots; 28@34 deg. Baumé, 5¾c. per gal.; 36@40 deg., 6¼c. per gal. f.o.b. Bayonne, N. J.

St. Louis—Dec. 15, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.05 per bbl.; 26@28 deg., $2.10 per bbl.; 28@30 deg., $2.15 per bbl.; 30@32 deg., $2.20 per bbl.; 32@36 deg., gas oil, 6.15c. per gal.; 38@40 deg., 7.23c. per gal.

Pittsburgh—Dec. 13, f.o.b. local refinery; 30@34 deg., fuel oil, 6¼c. per gal.; 36@40 deg., fuel oil, 6¾c. per gal.

Philadelphia—Dec. 17, 27@30 deg., $2.52@$2.58 per bbl.; 13@19 deg., $1.725@$1.785 per bbl.

Cincinnati—Dec. 14, tank-car lots f.o.b. local refinery, 24@26 deg. Baumé, 6¼c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

Chicago—Dec. 1, tank-car lots f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.35 per bbl.; 26@30 deg., $1.45; 30@32 deg., $1.65.

Boston—Dec. 20, tank-car lots f.o.b. 12@14 deg. Baumé, 4.65c. per gal.; 28@32 deg., 5.9c. per gal.

Dallas—Dec. 11, f.o.b. local refinery, 26@30 deg., $1.75 per bbl.

Tension Motor Base — The Tension Motor Base Co., 15 East 26th St., New York City, has devoted a short bulletin to the flexible tension motor base for either vertical, horizontal or inclined drives to insure a smooth vibrationless and noiseless operation.

Deaerating Heaters—The Cochrane Corp., Philadelphia, Pa., in this Bulletin 672 deals with the prevention of oxygen corrosion of piping, boilers, economizers and the like. The causes and prevention of red water, corrosion with zeolite-treated water are considered in reference to the use of deaerating heaters in protecting the modernized plant.

Surface Condensers—The Ingersoll-Rand Co., 11 Broadway, New York City, has issued bulletin No. 9027 on the surface condensers manufactured by the company. Sectionized drawings of external air cooler, single pass condenser, water-box surface condenser are given. Shell shape and tube staging, longitudinal distribution, air cooling steam jets, scaled tubes, water quantity, and the keeping of condensers clean are among the topics treated.

High Alumina Fire Brick—The A. P. Green Fire Brick Co., Mexico, Mo., has issued an illustrated booklet on Diaspore firebrick manufactured from high-alumina material. Kruzite, the super-refractory brick, uniform in size, is free from shrinkage, laminations and cracks. The Mizzou brand of high-alumina Diaspore has been designed to withstand severe operating conditions.

New Plant Construction

Calif., Exeter—City plans an election to vote $50,000 bonds for waterworks improvements including pump, tank on tower, etc.

Calif., Long Beach—Southern California Edison Co., 306 West 3rd St., Los Angeles, plans the construction of a steam power plant on Terminal Island here if the petition to the Bd. of Harbor Comrs. for a 35 year franchise to construct a discharge flume across city land is passed.

Calif., Los Angeles—Harpstrite Corp., 419 North Broadway, awarded contract for the construction of a 6 story apartment on Grove St. Estimated cost $500,000. L. A. Bryant, 700 South La Brea Ave., is architect.

Calif., Madera County—L. W. Cooper, Clk., plans to purchase a portable air compressor with complete equipment.

Calif., Pasadena—Chateau Du Jardin, is having preliminary plans prepared for the construction of a 6 story apartment on Grove St. Estimated cost $500,000. L. A. Bryant, 700 South La Brea Ave., is architect.

Calif., San Francisco — Bd. of Harbor Comrs., Ferry Bldg., is receiving bids for the construction of a ferry terminal including electric operating machinery on Hyde St. Estimated cost $100,000. F. G. White, Ferry Bldg., is engineer.

Colo., Denver—Bureau of Reclamation, will receive bids until Jan. 3, for two or three pumping units to deliver 10 sec. ft. each against a total head of 500 ft. motors for direct connection to above pumping units and hydraulically operated or water-motor operated discharge gate valves for Shell Rock pumping plant, Okanogan Project, Washington.

Conn., Devon—Connecticut Light & Power Co., I. W. Day, Pres., 107 West Main St., Waterbury, plans the construction of an auxiliary power plant here. Estimated cost $300,000. Electric generating equipment to cost $100,000 to $200,000 will be required.

Conn., Stamford—City will soon award contract for the construction of a sewage pumping station. Fuller & McClintock, 170 Broadway, New York, N. Y., are engineers.

Fla., Jacksonville—Graybar Electric Co., 334 East Bay St., will soon award contract for the construction of an electric light plant. Lockwood, Greene & Co., Healy Bldg., Atlanta, Ga., are engineers.

Ill., Chicago—Grant Park Hospital, c/o Schmidt, Garden & Erickson, 104 South Michigan Ave., Archts., awarded contract for the construction of a 5 story hospital at Grant Pl., Webster and Cleveland Aves., to Blome-Sinek Co., 33 South Clark St. Estimated cost $500,000.

Ill., Chicago—A. Goldstein, 134 North La Salle St., is having plans prepared for the construction of a 16 story apartment at Buena Ave. and Lake Shore Dr. Estimated cost $1,500,000. Rissman & Hirschfield, 64 West Randolph St., are architects.

Ill., Chicago—E. K. Ingal Building Corp., 2970 Sheridan Rd., is having sketches made for the construction of a 12 story hotel at 1118 Bryn Mawr Ave. Estimated cost $1,350,000. F. Stanton, 310 South Michigan Ave., is architect.

Ill., Chicago—Rebori, Wentworth, Dewey & McCormick, 332 South Michigan Ave., Archts., awarded general contract for the construction of a 19 story apartment at 2430 Lakeview Ave. to Dahl-Stedman Co., 11 South La Salle St. Estimated cost $1,000,000.

Ind., East Chicago—Manufacturer's Association, is having preliminary plans prepared for the construction of a hospital. Estimated cost $1,200,000. Architect not selected.

Ia., Dubuque—Rosenthal Theatre Corp., c/o J. Rosenthal, awarded contract for the construction of a 5 story hotel and theatre building at Iowa and Fifth Sts., to R. Levine & Co., 822 West 70th St., Chicago, Ill. Estimated cost $750,000.

Ia., Randolph—City is having preliminary plans prepared for the construction of a complete waterworks and distribution system including pumping equipment, mains, etc. Estimated cost $22,500. Henningson Engineering Co., National Bldg., Omaha, Neb., is engineer.

Ia., Sioux City—C. W. and G. L. Rapp, 190 North State St., Chicago, Ill., Archts., will receive bids until Dec. 31 for the construction of a 7 story theatre and office building here for Frances Building Co. Estimated cost $1,500,000. Lieberman & Hein, 190 North State St., Chicago, Ill., are engineers.

Mass., Amesbury—Merrimack Hat Corp., 60 Merrimack St., awarded contract for the construction of addition to boiler house to J. Moran, 11 Cedar St. Estimated cost $40,000.

Mass., Belmont (Boston P. O.)—Dept. of Mental Diseases, State House, plans the construction of a hospital. Estimated cost $3,000,000. Architect not selected.

Mass., Boston—A. A. Langewald, 86 Essex St., Engr., wants prices and catalogs for electric motors, generators, engines, power house equipment, etc., for power house.

Mass., Haverhill—Haverhill Electric Co., 121 Merrimack St., is having plans prepared for the construction of addition to switch house. Estimated cost $40,000. C. H. Tenney & Co., 200 Devonshire St., Boston, are architects.

Mass., Monson—A. D. Elles Mills Co., 288 Main St., awarded contract for the construction of a boiler house to F. T. Ley Co., Inc., 230 Boyleston St., Boston. Estimated cost $40,000.

Mass., Salem—Salem Electrical Co., c/o C. H. Tenney & Co., 200 Devonshire St., Boston, Engr., is having plans prepared for the construction of addition to switchboard building. Estimated cost $40,000.

Mich., Detroit—Public Lighting Comn., 176 East Atwater St., will soon award contract for furnishing and erecting an outdoor sub-station including 24,000 v. transformer, oil circuit breaker, etc. Smith, Hinchman & Grylls, 800 Marquette Bldg., are engineers.

Mich., Detroit—United Artists Corp., 159 East Elizabeth St., is having plans prepared for the construction of an 18 story theatre and office building including steam heating equipment, elevators, etc. C. H. Crane, 542 Griswold St., is architect.

Minn., Minneapolis — Minneapolis Gas Light Co., 16 South 7th St., plans an improvement program within the next several years consisting of the construction of a new oil gas plant and coal gas plant, also addition to water gas equipment including engines, etc. Estimated cost $1,000,000, $3,000,000 and $1,000,000 respectively.

Mo., Kansas City—Interurban Central Station Co., 1125 Scarritt Bldg., is having plans prepared for the construction of a 10 story office building, garage and service station including boilers, ventilation system, elevators, etc., at 10th and Grand Sts. Estimated cost $2,500,000. Wight & Wight, First National Bank Bldg., are architects.

Mo., Mound City—City plans waterworks improvements including pump house, pumps and motors. Estimated cost $5,500. Henningson Engineering Co., National Bank Bldg., Omaha, Neb., is engineer.

Mo., St. Louis—Water Dept., J. Pritchard, Dir., City Hall, will soon award contract for waterworks improvements including the superstructure of engine house, boiler house and coal receiving house, etc., at Howards Bend on the Missouri River. Estimated cost $900,000.

Neb., Adams—City, J. G. Fry, Clk., plans an election to vote $30,000 bonds for improvements to waterworks and distribution system including wells, pumps, tank on tower, etc. Estimated cost $30,000. Henningson Engineering Co., National Bldg., Omaha, is engineer.

N. J., Atlantic City—L. J. Brooks, 65 Madison Ave., New York, N. Y., Archt., will soon receive bids for the construction of a 19 story hotel including 5 electric elevators, etc., here. Estimated cost $1,500,000. Owner's name withheld.

N. J., Newark—L. Bamberger & Co., Halsey St., is having plans prepared for the construction of a 16 story addition to department store including elevators at Washington Bank and Halsey St. Estimated cost $10,000,000. I. J. Hunt, 30 North Michigan Blvd., Chicago, Ill., is architect. M. C. Schwab, 30 North Michigan Blvd., Chicago, Ill., is engineer.

N. J., Totowa (mail Paterson)—C. N. Leathem, State Bldg., Trenton, Archt., will receive bids until Jan. 7 for the construction of a group of buildings including power house, boilers, generators, etc. at Feeble Minded Colony for State Institutions & Agencies. Estimated cost $500,000.

N. Y., Brooklyn—Garned Realty Co., 489 5th Ave., New York, will soon receive bids for the construction of a theatre and office building at Ocean Ave. and Kings Highway here. Estimated cost $1,000,000. P. La Velle, 505 5th Ave., New York, is architect.

N. Y., New York — Ewing & Ives, 508 Park Ave., awarded contract for the construction of an 11 story apartment to Starrett Bros., 292 Madison Ave. Estimated cost $600,000. Three electric elevators, etc. will be installed.

N. Y., New York—Inwood Consumers Ice Mfg. Co., 9th Ave. and 213th St., awarded contract for the construction of an ice plant to Wigton-Abbott Corp., 552 West 23rd St. Estimated cost $100,000. Ice making machinery will be installed.

N. Y., New York—New York Evening Journal, William St., is having plans prepared for the construction of a 5 story publishing house and office building at 56th

St. and 8th Ave. Estimated cost $1,000,000. G. B. Post & Sons, 101 Park Ave., are architects.

N. Y., New York—Roxy Theatre Corp., 383 Madison Ave., is having plans prepared for the construction of a theatre including refrigeration system, at 58th St. and Lexington Ave. Estimated cost $3,000,000. W. W. Ahlschlager, 65 East Huron St., Chicago, Ill., is architect. Engineer not selected.

N. Y., New York—Three Hundred Thirty West Forty Second St. Corp., J. A. Larkin, 1457 Broadway, will soon receive bids for the construction of a 110 story office building including 10 elevators, etc., at 326-346 West 42nd and 327-345 West 41st St. Estimated cost $22,500,000. J. A. & E. L. Larkin, 1457 Broadway are architects and engineers. A. D. Stark, 45 West 45th St., is associate engineer.

N. Y., Rochester—Caneadea Power Corp., subsidiary of the Rochester Gas & Electric Corp., awarded contract for the construction of a power dam, 143 ft. high including 1,600,000,000 gal. reservoir, power plant, etc. on the Caneadea Creek near here, to Gannett, Seelye & Fleming Inc., 1 North Market Sq., Harrisburg, Pa. Estimated cost $850,000.

N. C., Henderson—City, S. R. Chavasse, Mayor, will receive bids until Jan. 12 for waterworks improvements including water purification plant, pump house, pumping equipment, electrical control equipment, etc. W. C. Olsen, Rg. B. & L. Bldg., Raleigh, is engineer.

N. C., Raleigh—City plans to authorize the issuance of $20,000 bonds for refrigeration machinery, equipment and apparatus for city market.

N. D., Mandan—Northern Pacific Ry. Co., St. Paul, Minn., is having plans prepared for the construction of a steam operated power plant. Estimated cost $100,000. H. E. Stevens is chief engineer.

O., Akron—City awarded contract for the construction of a 5 story hospital at Bowery and West Buchtel Ave., to Carmichael Construction Co., Central Savings & Trust Bldg. Estimated cost $500,000.

O., Akron—M. O'Neil Co., South Main St., will soon award contract for the construction of a 4 and 6 story department store, warehouse and garage including refrigeration plant, three water tube boilers, one 425 kw., 150 r.p.m. and one 260 kw., 180 r.p.m. engines, 12 electric elevators, etc. Estimated cost $3,000,000. Graham, Anderson, Probst & White, 80 East Jackson Blvd., Chicago, Ill., are architects.

O., Chagrin Falls—Bd. of Education, H. B. Pugsley, Clk., is having plans prepared for the construction of a central heating plant including new boilers, etc. Estimated cost $40,000. A. M. Allen & Co., 7016 Euclid Ave., Cleveland, are architects and engineers.

O., Mansfield—City, F. B. Wolff, Dir. of Service, will receive bids until Dec. 30 for three deep well pumps with remote control and one 1,000,000 g.p.d. motor driven centrifugal pump.

O., Xenia—Ohio Soldiers' and Sailors' Orphans Home, is having plans prepared for the construction of a hospital, nursery, etc. including central heating equipment. Total estimated cost $450,000. H. B. Briggs, Ohio-Hartman Bldg., Columbus, is state architect.

Okla., Mand—City is in the market for a new 50 gal. deep well pump and motor for waterworks. L. H. Ogee, mayor.

Okla., Talaga—City plans an election to vote $15,000 bonds for the construction of an electric light plant.

Pa., Philadelphia — Philadelphia Electric Co., 10th and Chestnut Sts., will soon award contract for the construction of a steam station at Ninth and Willow Sts.

Tex., Alpine — Central Power Co., D. Littleton, had plans prepared for improvements to plant including additional engine power unit, air compressor, etc. Estimated cost $11,000. Private plans.

Tex., Coolidge—City voted $20,000 bonds for waterworks improvements including pumping equipment, mains, etc. J. H. Gamel, mayor.

Tex., Crystal City — Central Power & Light Co., Frost Bldg., is receiving bids for improvements to power plant. Estimated cost $18,000. Private plans. A new engine unit will be installed.

Tex., Eastland—Eastland Mineral Water Co., K. C. Ferguson, Pres., 204 Exchange Bank Bldg., will receive bids about Jan. 1, for the construction of a bath house and clinic including heating plant, air cooling equipment, etc. Private plans.

Tex., Gonzales—Cement Works, Inc., c/o A. O. Neuman, Pres., has acquired a site and plans the construction of a plant for the manufacture of concrete sewer pipe. Estimated cost $70,000. Private plans. The plant will be electrically operated, equipment will be required.

Tex., Laredo—A. C. Richter, H. C. Wood & Associates, 907 Travis Bldg., San Antonio, awarded contract for the construction of a 12 story hotel to Kelwood Co., 907 Travis Bldg. Estimated cost $500,000. Refrigeration system, elevators, etc. will be installed.

Tex., Midland — Morgan Utilities, Inc., A.O.U.W. Bldg., Little Rock, Ark., has been granted franchise to construct an electric light plant here. Estimated cost $200,000. Private plans. Owner is in the market for machinery.

Tex., Temple—Scott & White Hospital, A. C. Scott, awarded contract for the construction of a power plant to Love Construction Co. Estimated cost $21,172. One engine unit will be installed.

Vermont — Green Mountain Power Co. awarded contract for the construction of a hydro electric power development at Marshfield and Montpelier to Sanders Engineering Co., 102 Exchange St., Portland, Ore.

Wash., Seattle — Arcade Building & Realty Co., Arcade Bldg., awarded contract for the construction of a 10 story addition to arcade building at 2nd and Union Sts., to Tuefel & Carlson, 1320 5th Ave. Estimated cost $1,500,000. Forced air heating and ventilation systems providing washed air with humidity control will be installed.

Wash., Seattle — Paramount Building Corp., awarded contract for the construction of 9 story theatre and apartment building at Ninth and Union Sts., to Rounds-Clist & Co., Walker Bldg. Estimated cost $1,500,000.

Wis., Janesville—Schlueter Boiler Works, 320 North Main St., plans the construction of a boiler house. Estimated cost $40,000. Architect and engineer not selected.

Wis., Madison—University of Wisconsin, J. S. Phillips, Bus. Mgr., plans the installation of additional boilers, heating tunnels, etc. Estimated cost $404,300. Engineer not selected.

Wis., Menasha—City, J. F. DeCaro, Clk., will receive bids until Jan. 4, for waterworks improvements including one 1,500 g.p.m. centrifugal pump and 75 hp. motor, etc.

B. C., Vancouver—City will receive bids about March for the construction of a 4 story hospital at Willow and 10th Aves. Estimated cost $750,000. A. J. Bird, City Building Dept., is architect.

Ont., Arnprior—Town Council plans the construction of a power house and dam, 3,000 hp. capacity on the Madawaski River. Estimated cost $454,168.

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Volume 64 December 28, 1926 Number 26

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Steam Corrodes Iron 985
The Machinery Erector as a Sales Influence 993
Making a Gasket Cutter 994
The Engineering Graduate 995
The Derelict Engineer 996
Lively Discussion on Pipe Welding Features A. W. S. Meeting 999
Recent Publications 1000

Directory of Engineering Service 70
Searchlight Section 71-73
Index to Advertisers Last Page

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Moments with the Ad Editor

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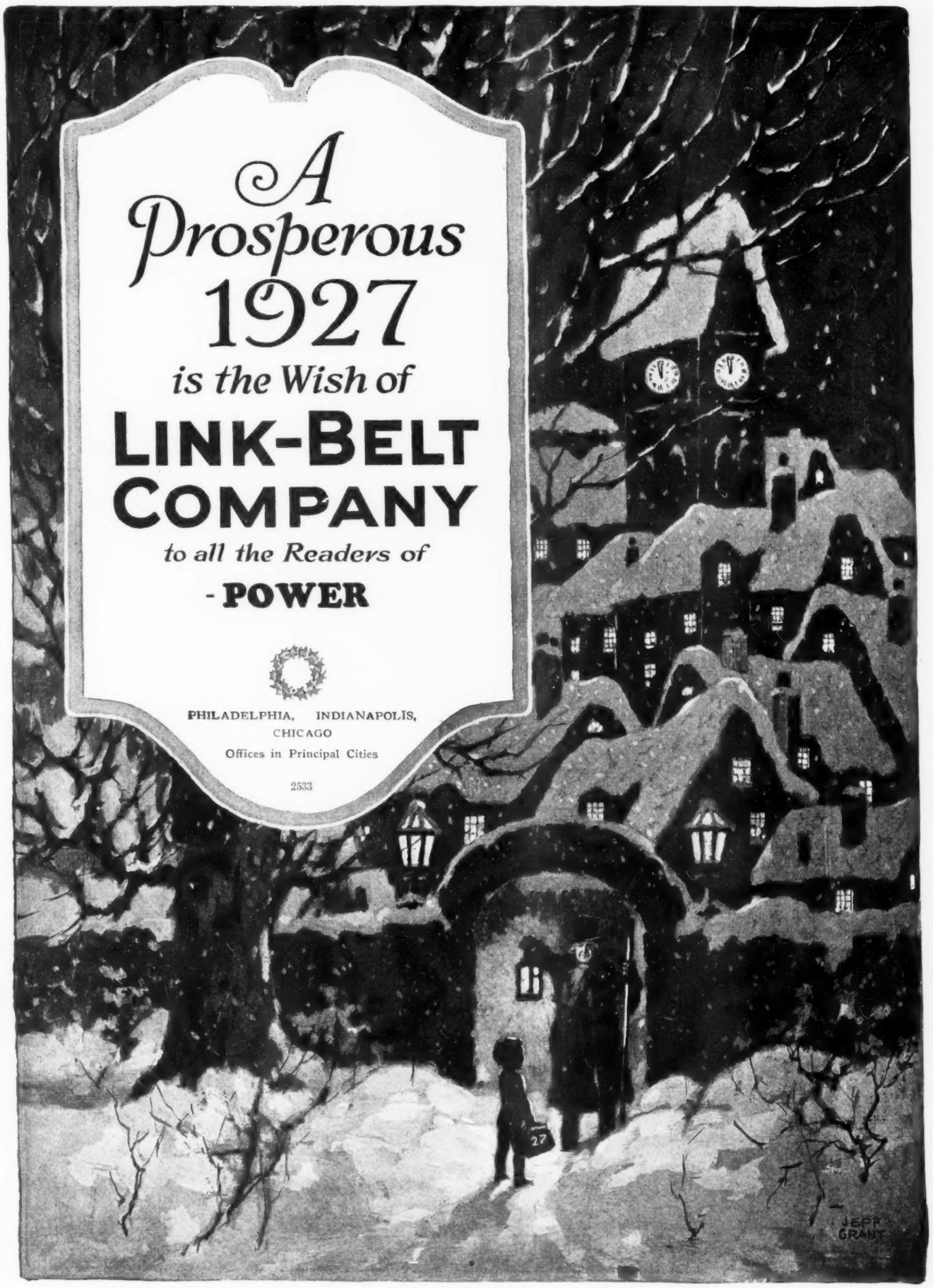
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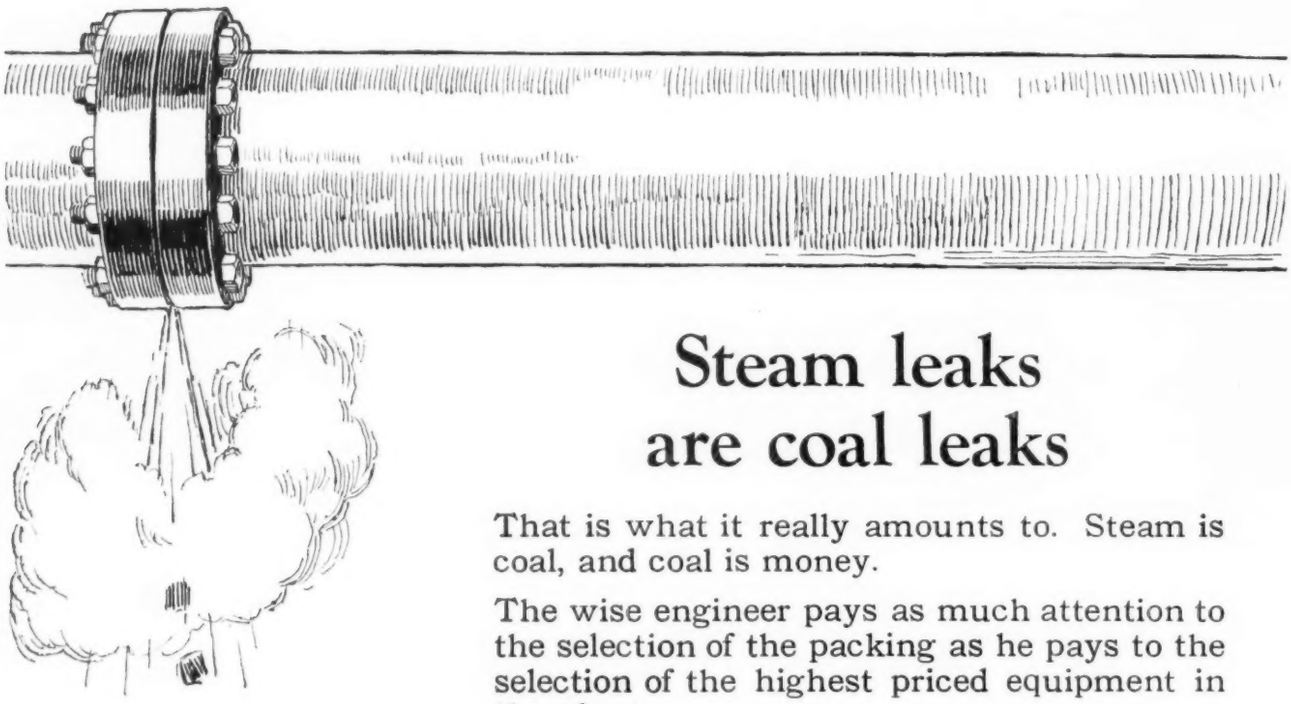

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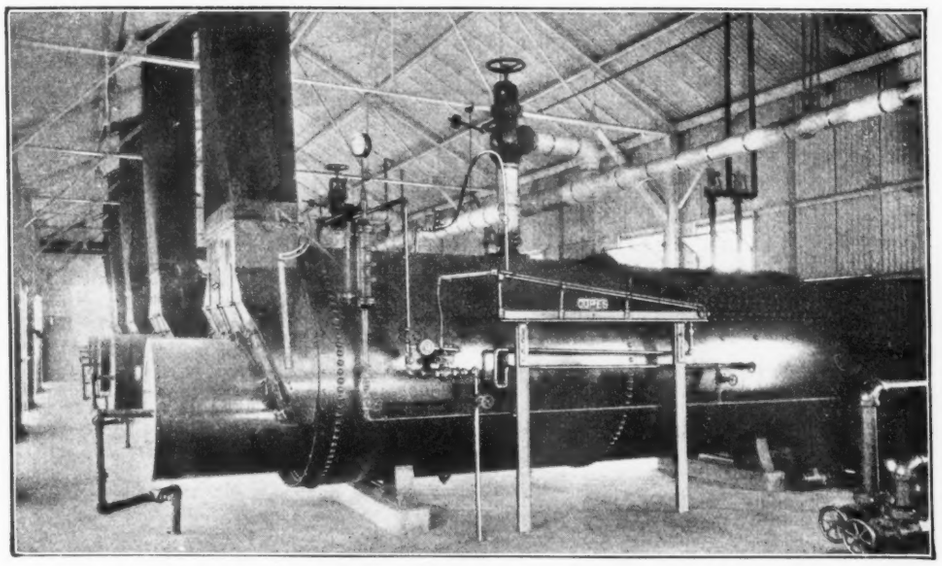

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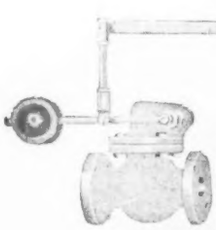

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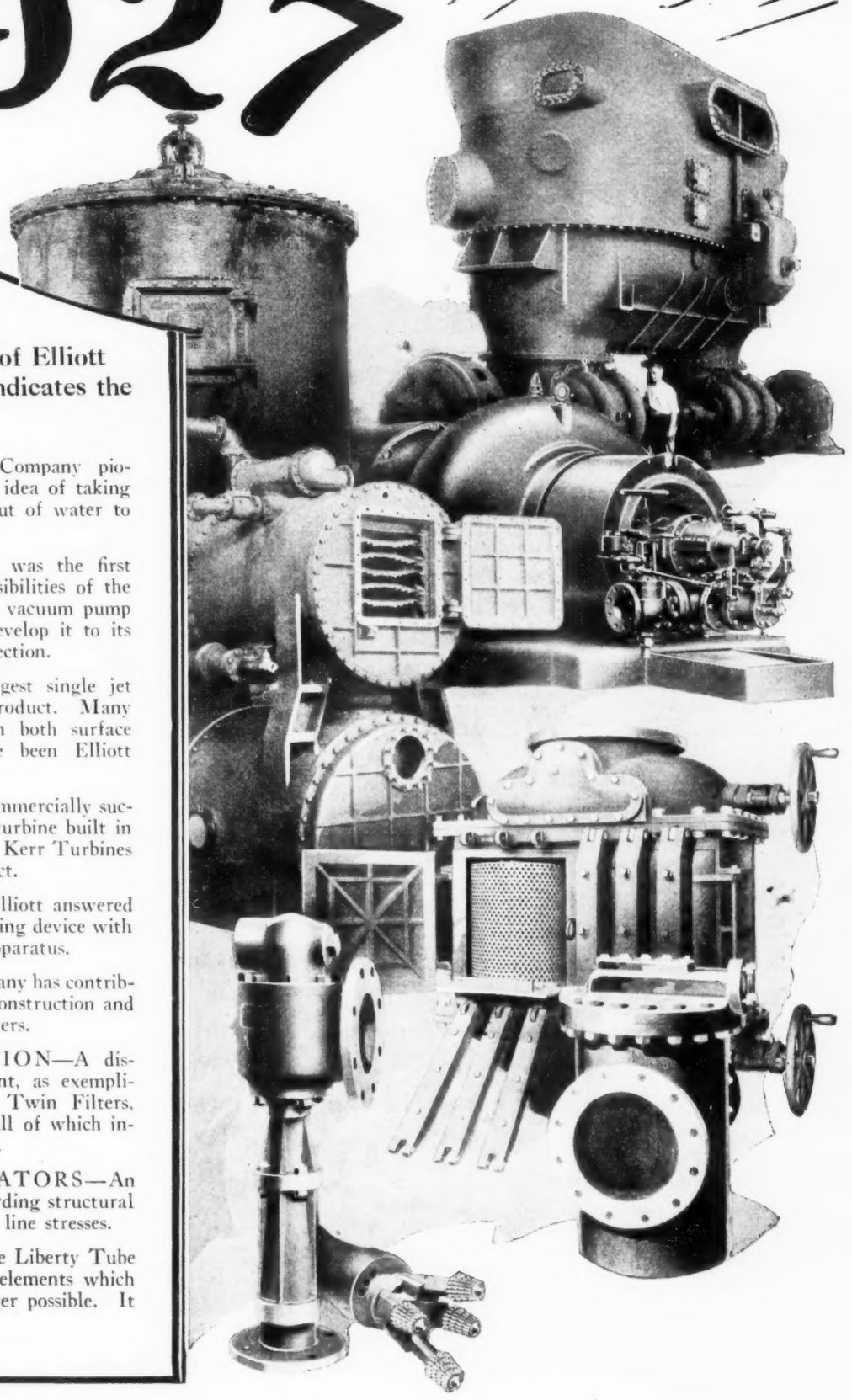

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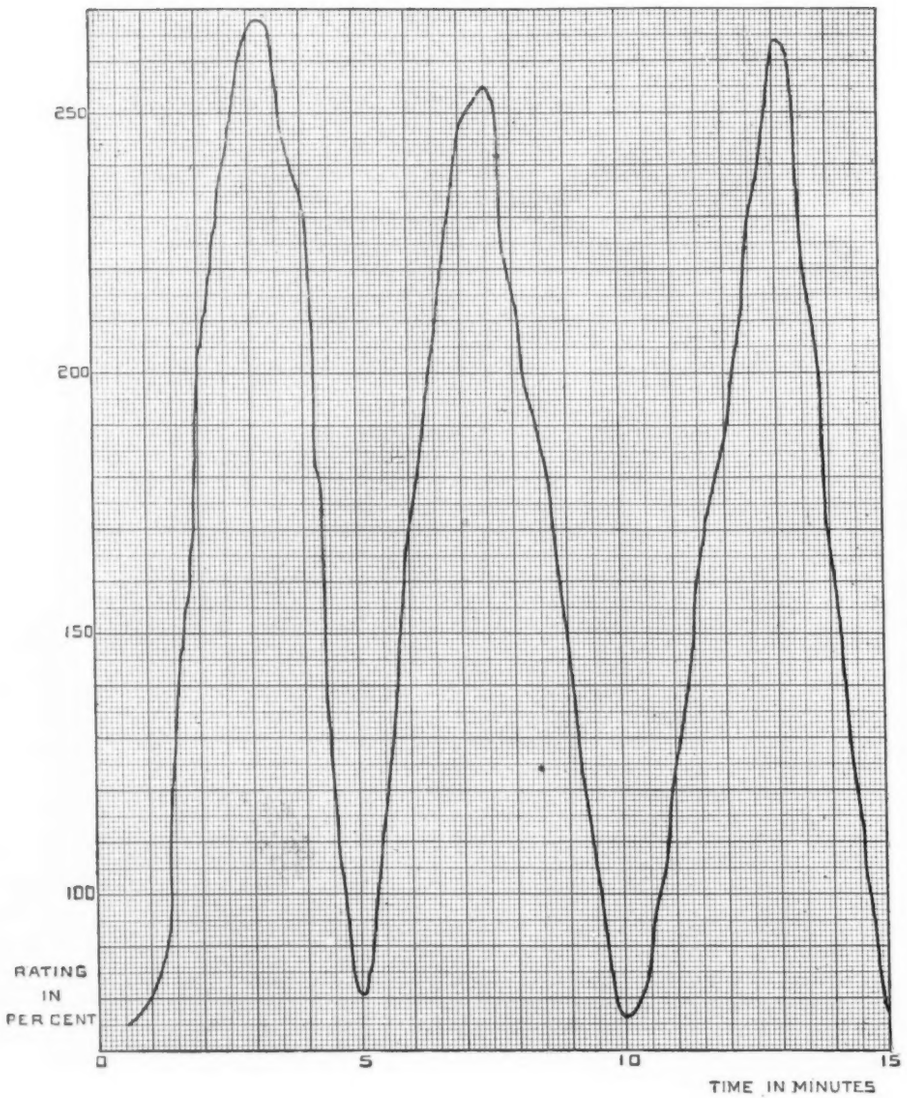

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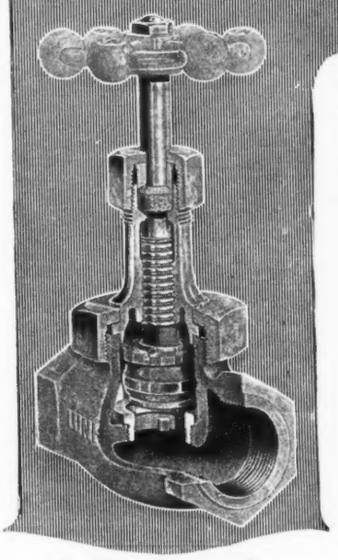

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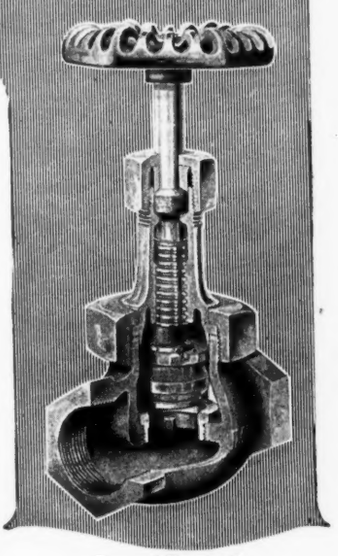

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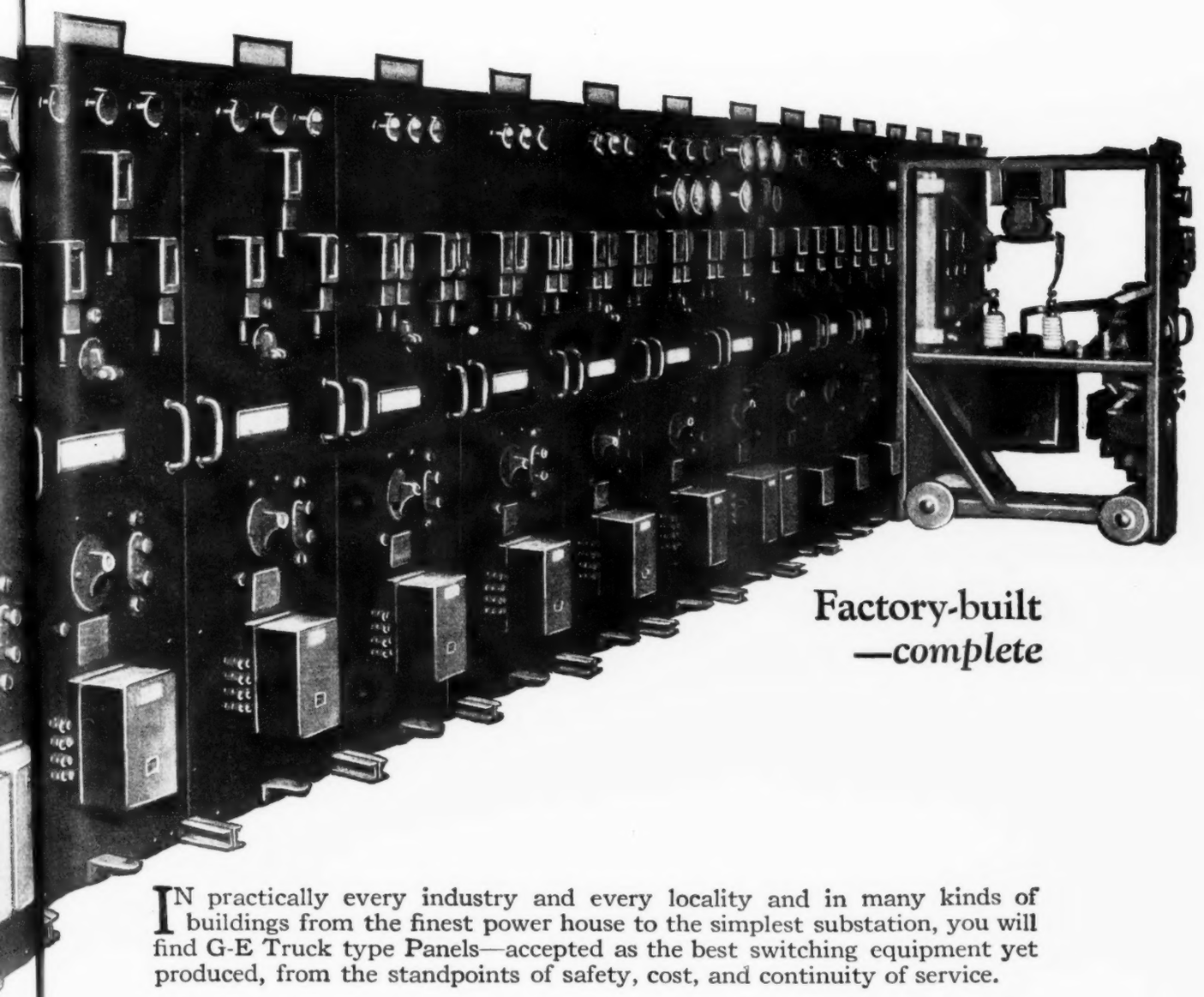

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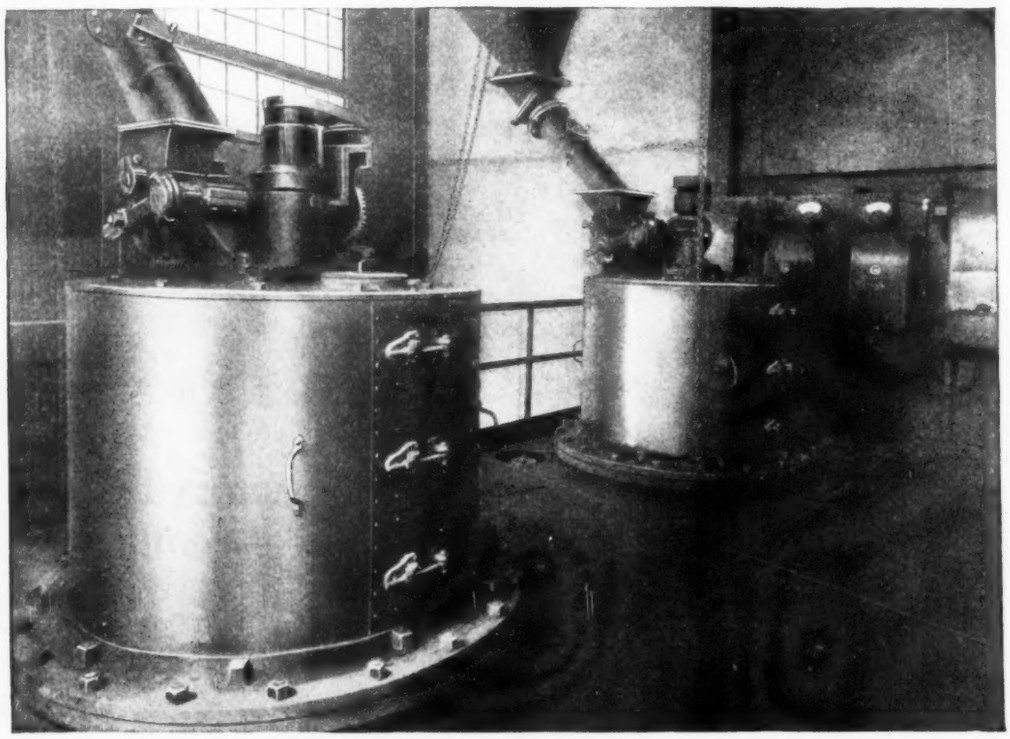

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Salt Lake City, Harrison & Co., Atlas Block

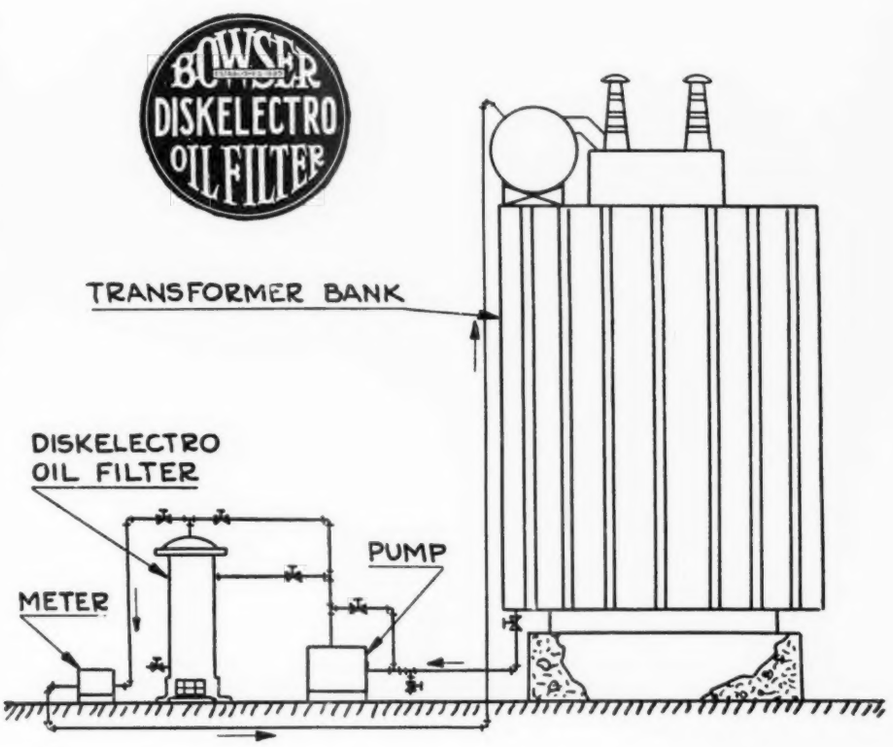
"Diskelectro," *the filter for transformer oils*

Complete purification of transformer and switch oils by "edge" filtration between thin discs of metal. All water and impurities removed. Oils restored to full dielectric strength by one passage. Simple, rapid, economical filtration.

Diskelectro is furnished in three sizes, to handle capacities of 75 to 400 gallons per hour.

Advantages

1. Satisfactory results in any weather. Filter air tight.
2. No moving parts, consequently no wear.
3. Filter takes oil from, and returns direct to transformer.
4. Only one pump and motor required.
5. Unlimited volume. Complete dehydration.
6. No heaters required.
7. Operating costs negligible.
8. No inconvenience, delay, or expense beyond occasional quick, simple backwashing with oil



For complete illustrated descriptions of "Diskelectro," the filter for transformer oils, address your request to Dept. 6.

Lubrication and Filtration Division

S. F. BOWSER & CO., INC.
FORT WAYNE, INDIANA

Lubrication Engineers and Manufacturers

Gould Street Station A

Helping Baltimore Grow
And Keeping Ahead of It
1926 Construction Budget
BETTER PUBLIC SERVICE
1926
ELECTRIC
Power Plant $2,071,518.98
(This covers a new Electric Generating Station to be located on the waterfront in the southern section of the City, and expenditures for Structures, Boiler Equipment, Switching and other Electrical Equipment in existing power plants.)
Sub-stations 868,281.80
(This covers land, structures and equipment for new sub-stations and expenditures for equipment in existing sub-stations.)
Transmission and Distribution Systems 1,956,537.80
(This covers expenditures to be made for overhead and underground transmission and distribution systems, consisting of poles, wire, cable, transformers, etc., and meters and their
Baltimore is growing. Evidences of its growth are apparent everywhere.
Good Public Service
THE GAS & ELECTRIC CO.
Telephone Plaza 8000
General Service Department
Is Your Service Good?
If Not, Please Let Us Know
One of the Company's Informative Advertisements which appeared in the Baltimore Newspapers

Combustion Corporation

International Combustion Building
200 Madison Ave., (Entrances on 35th & 36th Sts.) New York

A SUBSIDIARY OF INTERNATIONAL COM

Almost Completed

Interest now centers upon the Gould Street Station of the Consolidated Gas, Electric Light & Power Co., Baltimore, Md., which is to begin operation shortly.

This plant represents advanced design throughout. Equipment furnished by Combustion Engineering Corporation includes—

Lopulco Pulverized Fuel Systems.

Furnaces constructed of C-E Fin Furnace Walls.

Air preheated by C-E Air Heaters.

Coal pulverized by Raymond Super Mills.

INTERNATIONAL COMBUSTION ENGINEERING CORPORATION

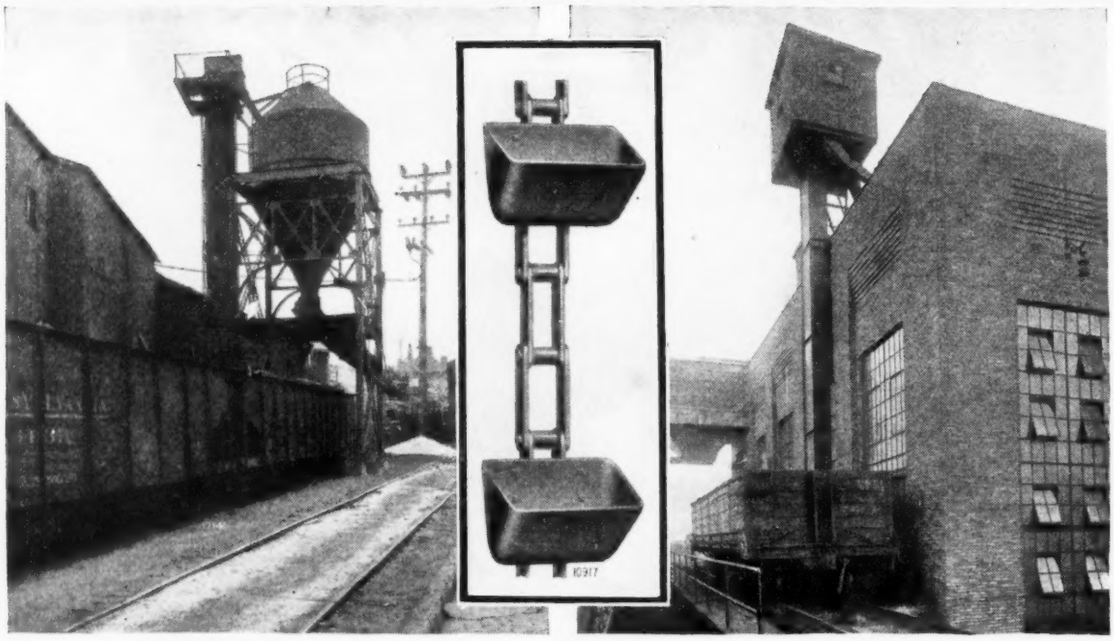
- ✓ Lopulco Pulverized Fuel System
- Frederick Multiple Retort Stoker
- Self-contained Stoker
- Coxe Stoker
- Type E Stoker
- Type D Stoker
- Type K Stoker
- Type H Stoker
- Green Natural Draft Stoker
- Green Forced Draft Stoker
- ✓ C-E Fin Furnaces
- ✓ C-E Air Heaters
- C-E Unit System (Pulverized Fuel)
- Grieve Grates
- Combusco Ash Conveyors
- Quinn Oil Burning Equipment
- Combustion Steam Generator
- Ladd Water Tube Boilers

Engineering

ation Offices throughout the World

COMBUSTION ENGINEERING CORPORATION

8 Reliable Coal & Ashes Handling Methods



Handling Ashes Handling Coal

Method No. 3—JEFFREY STANDARD BUCKET ELEVATORS

For Power Plants of Medium or Small Capacity—Handle either Coal or Ashes

JEFFREY Standard Bucket Elevators have their application to Boiler Houses in the handling, as separate units, of either coal or ashes.

Where coal is to be delivered but a short distance from an elevator to storage space, the elevator often can be extended high enough to spout the coal to several storage points or boiler hoppers. For such cases a Jeffrey Elevator in connection with one or more gravity spouts becomes a maximum of handling economy.

The Bucket Elevator is also used to feed distributing conveyors such as the Scraper, Belt and Spiral types.

Jeffrey Standard Bucket Elevators can be furnished with or without casings. Their capacities range from 6½ to 36 tons per hour, with vertical lifts of from 10 to 75 feet.

The next advertisement in this series will appear in the January 11th issue

The Jeffrey Manufacturing Company
932-99 North Fourth St., Columbus, Ohio

New York, Buffalo, Rochester, N. Y., Philadelphia, Pittsburgh, Scranton, Pa., Boston, Cincinnati, Cleveland, Detroit, Chicago, Charleston, W. Va., Milwaukee, St. Louis, Denver, Salt Lake City, Los Angeles, Birmingham, Charlotte, N. C., Montreal

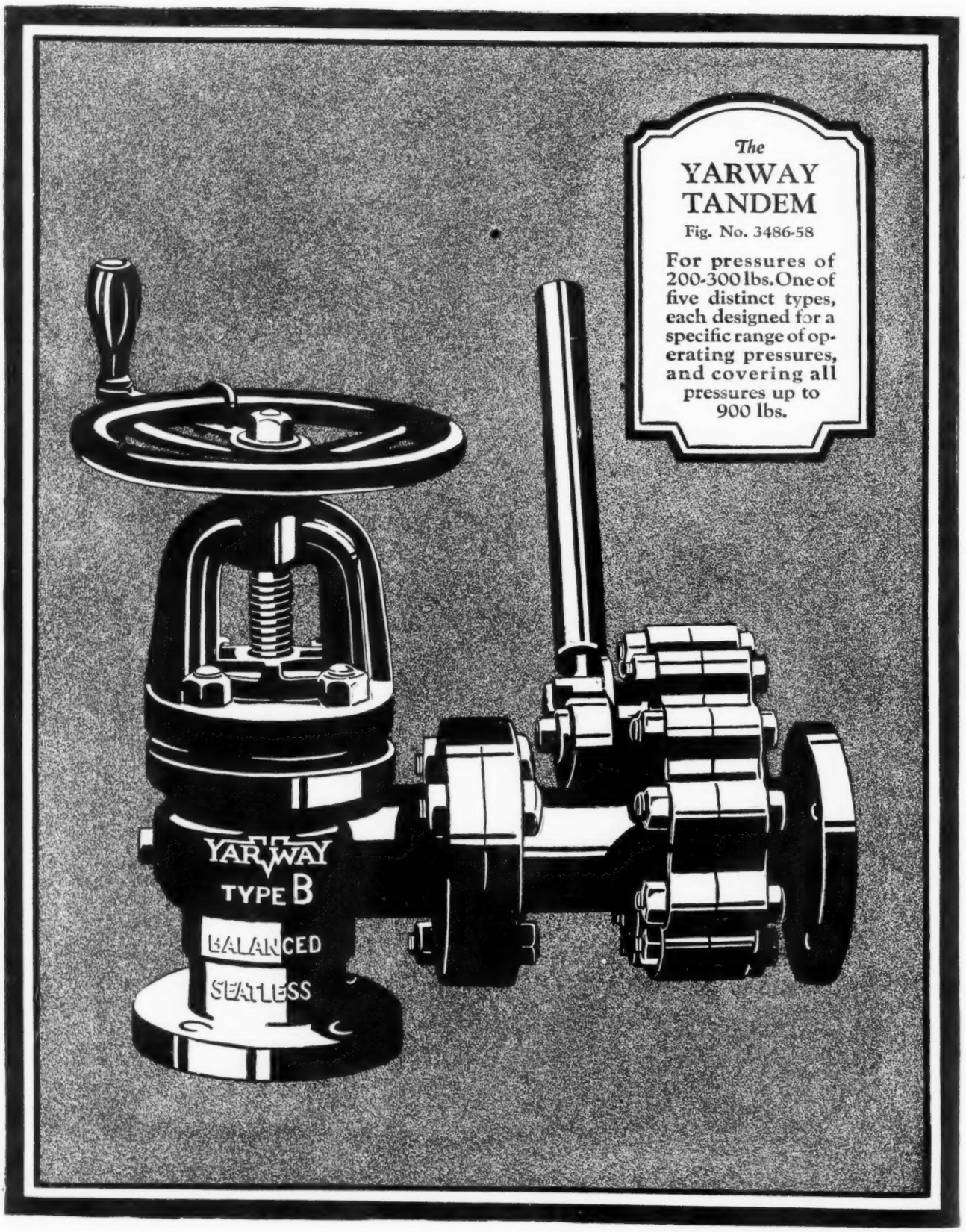
JEFFREY
MATERIAL HANDLING EQUIPMENT

Jeffrey Products

Elevators—Conveyors
Portable Loaders
Coal and Ashes Handling Equipment
Skip Hoists
Chains and Attachments
Sprocket Wheels—Gears
Crushers—Pulverizers
Sand and Gravel Handling, Washing and Screening Equipment
Locomotives
Coal Mine Equipment
Tipple Equipment
Ventilation Fans

OIL
ENGINES
PROVIDE-ECONOMICAL
EFFICIENT - DEPENDABLE-
POWER FOR ALL PURPOSES
POWER problems of many modern industries are being solved by the use of Ingersoll-Rand solid-injection oil engines.
Vertical engines, in sizes from 125 hp. to 1200 hp., are in service in many power plants, ships, and locomotives.
The largest fleet of Oil-Electric ships in the world under private ownership, and Oil-Electric locomotives in service on eight prominent railroads and several industries, are equipped with Ingersoll-Rand vertical oil engines.
Horizontal oil engines, direct-connected to ammonia and air compressors, or belted to pumps, generators and line-shafting, are proving highly profitable investments for many owners. These units are built in 55-, 110-, and 150-hp. sizes.
Consult an Ingersoll-Rand engineer when in need of economical, dependable, and efficient power for any purpose. Oil Engine Bulletins will be sent upon request.
SOLID-INJECTION-MULTI-
CYLINDER-HORIZONTAL-
VERTICAL-4 CYCLE-
SINGLE ACTING
INGERSOLL-RAND COMPANY
11 Broadway New York City
Offices in principal cities the world over
For Canada, Refer Canadian Ingersoll-Rand Co., Ltd.,
260 St. James Street, Montreal, Quebec
95-SOB
R-1259
Ingersoll-Rand

YARWAY


The
YARWAY
TANDEM
Fig. No. 3486-58
For pressures of 200-300 lbs. One of five distinct types, each designed for a specific range of operating pressures, and covering all pressures up to 900 lbs.
YARWAY
TYPE B
BALANCED
SEATLESS

BLOW-OFF VALVES

Plants where 25 or More YARWAY BLOW-OFF VALVES have been in service MORE THAN FIVE YEARS

No. in use		
510	Bethlehem Steel Co.	Several plants
440	Cleveland Electric Illuminating Co.	Cleveland, O.
272	Philadelphia Electric Co.	Several plants
230	Procter & Gamble, Port Ivory, Kansas City, Hamilton, Ont.	
215	Standard Oil Co.	Several plants
185	Ford Motor Co.	Several plants
158	Illinois Pipe Line Co.	Several plants
148	American Woolen Co.	Several plants
141	Republic Iron & Steel Co.	Youngstown, O.
135	Cambria Steel Co.	Johnstown, Pa.
120	Milwaukee Elec. Ry. & Light Co.,	Milwaukee, Wis.
112	Firestone Tire & Rubber Co.	Akron, O.
110	Baltimore Copper Smelting & Rolling Co.,	Baltimore, Md.
110	The Texas Co.	Several plants
100	Edison Electric Illuminating Co.	Brooklyn, N. Y.
97	Nebraska Power Co.	Omaha, Nebr.
92	New York Steam Corp.	New York, N. Y.
86	Lehigh Coal & Navigation Co.	Three plants
85	Atlantic Refining Co.	Several plants
81	Champion Fiber Co.	Canton, N. C.
77	Elk Tanning Co.	Ridgway, Pa.
70	American Smelting & Refining Co.,	Hayden, Arizona, and Omaha, Nebr.
67	Ohio Public Service Co.	Warren and Mansfield, O.
66	Grasselli Chemical Co.	Several plants
65	Pennsylvania Salt Co.	Several plants
63	Semet-Solvay Co.	Several plants
63	Solvay Process Co.	Syracuse, N. Y.
62	McKinney Steel Co.	Cleveland, O.
62	American Locomotive Co.	Three plants
57	Jones & Laughlin Steel Co.,	Two plants in Pennsylvania
56	American Steel & Wire Co.	Several plants
55	Rhode Island Co.	Providence, R. I.
53	American Brass Co.,	Ansonia and Torrington, Conn.

No. in use		
52	General Electric Co.,	Schenectady, N. Y., and Erie, Pa.
51	Connecticut Light & Power Co.	Waterbury, Conn.
49	Kimberly-Clark Co.	Two plants in Wisconsin
48	Bureau of Water	Philadelphia, Pa.
48	Toledo Railway & Light Co.	Toledo, O.
47	Columbus Railway Power & Light Co.,	Columbus, O.
46	A. C. Lawrence Leather Co.	Peabody, Mass.
46	Dixie Portland Cement Co.	Richard City, Tenn.
46	Farr Alpaca Co.	Holyoke, Mass.
46	Berwind-White Coal Mining Co.	Windber, Pa.
40	Lakeview Pumping Station	Chicago, Ill.
40	Winchester Repeating Arms Co.	New Haven, Conn.
38	Worcester Electric Light Co.	Worcester, Mass.
38	American Rolling Mills Co.	Middletown, O.
36	Pierce Oil Corp.	Sand Springs, Okla.
34	Duquesne Light Co.	Pittsburgh, Pa.
33	Potomac Electric Co.	Washington, D. C.
33	Westinghouse Electric & Mfg. Co.,	Pittsburgh, Pa.
32	Ohio Power Co.	Canton, O.
32	United Furnace Co.	Canton, O.
31	Torresdale Pumping Station	Philadelphia, Pa.
31	U. S. Industrial Alcohol Co.	Baltimore, Md.
30	Canadian Pacific Railway Co.	Montreal, Quebec
29	Great Western Sugar Co.	Three plants
29	Clinchfield Portland Cement Co.	Kingsport, Tenn.
29	Astoria Light, Heat & Power Co.,	Astoria, Long Island, N. Y.
28	Union Pacific Coal Co.	Rock Springs, Wyo.
27	University of Illinois	Urbana, Ill.
27	N. Y. C. R. R. Co.	New York
27	Atlantic Mills	Olneyville, R. I.
26	U. S. Navy Yard	Bremerton, Wash.
26	Vesta Coal Co.	California, Pa.
26	Libby, McNeill & Libby Co.	Several plants
26	Lorain Steel Co.	Johnstown, Pa.

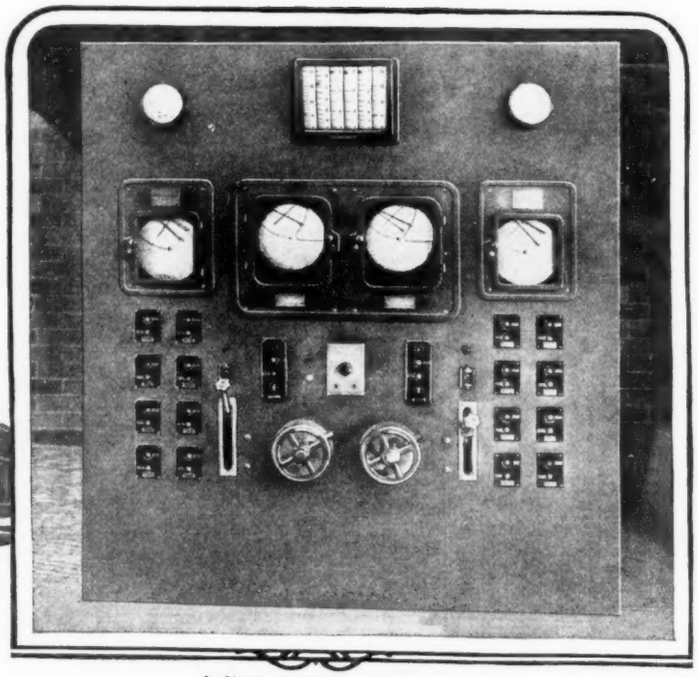
83% of Sales on Repeat Orders

Yarnall-Waring Company
Mermaid Avenue
PHILADELPHIA, PA.

TEN THOUSAND PLANTS ARE YARWAY-EQUIPPED

BAILEY METERS

Master Panel Board



Individual Boiler Panel Board

THE 3060 hp. Stirling Boilers fired with pulverized coal at the new large Middle Western Central Station shown above are each equipped with a boiler panel board and Bailey Metering Equipment as indicated.

The boilers each have two steam outlets, as well as two gas outlets with an economizer at each outlet. A Bailey Totalizing Boiler Meter consisting of two interconnecting recorders is used to record the total Steam Flow from the two steam lines, the Air Flow through two sections of the boiler and the Furnace Draft.

The recorders on the extreme left and right of the above panel board are Bailey Temperature Recorders, having four pens each to record Flue Gas Temperature from each of the two boiler outlets as well as from each of the two economizers. Two Superheated Steam Temperatures as well as two Feed Water Temperatures are recorded on the other Temperature Recorder chart.

A Bailey Multi-Pointer Gage, Type P6F, as shown at the top of the panel board, indicates two Primary Air Pressures, Furnace Draft, Draft at each of the two boiler outlets and Economizer Outlet Draft.

Bailey Meter Control installed on the boilers at this station for automatically regulating the supply of fuel and air in accordance with the demand for steam, insures test results being obtained in every-day operation.

Write for New Boiler Meter Bulletin No. 43

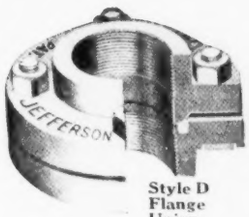
BAILEY METER CO.

A BABCOCK & WILCOX ORGANIZATION

2011 East 46th Street CLEVELAND, OHIO

Bailey Meter Company, Ltd., Montreal, Que. Industrial Combustion Engineers, Ltd., London, Eng.

Jefferson



Style D Flange Union

Special Features:

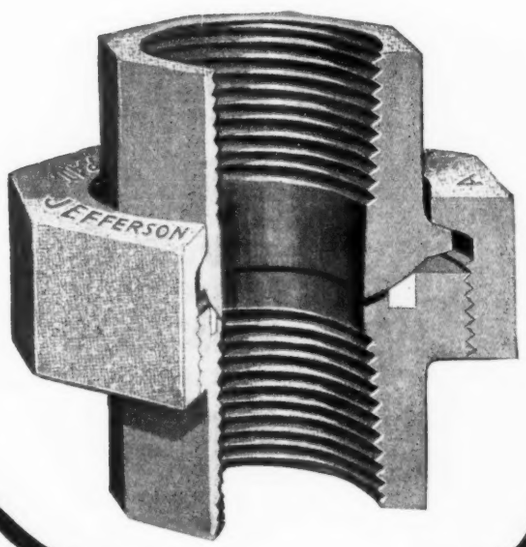
Made of Air Refined Malleable Iron.

Brass Seat Ring located in a recess away from the runway of the fitting (patented feature).

Briggs tapered pipe threads.

Large amount of play in the ball end (an especially valuable feature when pipes are not in line).

Joints ground in pairs (self-seating and absolutely tight).



The Secret

The secret of Jefferson Unions TIGHTNESS — permanently leakproof service—is not difficult to discover.

Brass and iron ground together to a ball and socket joint, that will let nothing get by. That's the secret.

Furthermore, brass and iron cannot corrode and stick together. This means that you can take any Jefferson Union apart and use it over and over again—many times. Each time you reinstall it, you will find the joint to be as tight as before.

Why not investigate, and learn the reasons for the overwhelming number of repeat orders for Jefferson Unions.

JEFFERSON UNION CO.
LEXINGTON, MASSACHUSETTS

ELGIN

Firestone

REPUBLIC

NEW YORK CENTRAL LINES

DUCO

DUPONT

FISK

Westinghouse

Goodrich

BAKELITE

JOSEPH T. RYERSON & SON INC.

FAIRBANKS-MORSE

Prest-O-Lite

Ingersoll-Rand

CELOTEX

GARGOYLE Mobiloil Make the chart your guide

Bauer & Black

INLAND STEEL CO

VALVE-IN-HEAD Buick MOTOR CARS

IVORY 99 44/100% PURE

Steward-Warner

Miller

CARNEGIE STEEL COMPANY

Victrola

Eastman Kodak Company,

COLGATE'S

STANDARD OIL COMPANY

PORTLAND CEMENT

The Quaker Oats Company

Hires

TEXACO

CHEVROLET

WAHL

JONES & LAUGHLIN STEEL CORPORATION

THE YOUNGSTOWN SHEET AND TUBE COMPANY

JOHNS-MANVILLE

BETHLEHEM

SUNOCO

NILES-BEMENT-POND CO.

Western Electric

GOODYEAR

EQUIPPED

Burlington Route

AMAIZO BRANDS

SINGER SEWING MACHINES

SINCLAIR OILS

TIMKEN

Swift & Company

REPUBLIC FLOW METERS COMPANY

EXECUTIVE OFFICES AND PLANT: 2222 DIVERSEY PARKWAY, CHICAGO, ILL.

Branch Offices in 25 Principal Cities

REPUBLIC FLOW METERS

Republic System

CO_2 Recorders
Draft Instruments
Coal Meters
Recording Pyrometers
Indicating Pyrometers

Boiler Meters
Meters, Water and Gas
Meters, Air and Steam
Liquid Level Indicators
and Recorders

$2.45 Per Year Return for Every Dollar Invested in Tracyfiers In a Central Station

$1.43 per year in a Paper Mill.
$1.39 per year in a Steel Plant.
$1.34 per year in an Oil Refinery.
$1.97 per year in a Cement Plant.

TRACYFIERS

Have proved a profitable investment for these companies—because they assure the continuous delivery of

Standard Specification Steam

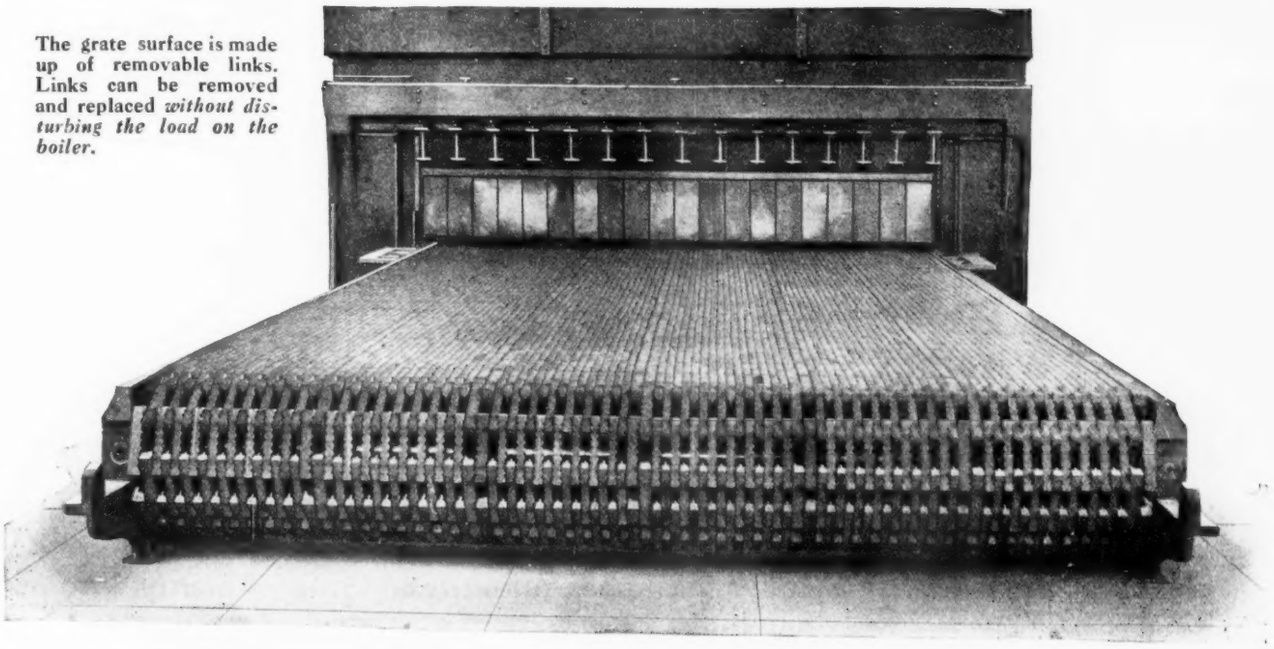
Which of these Bulletins shall we send you?

- ☐ No. 40. Certified Savings due to the use of Standard Specification Steam.
- ☐ No. 39. Standard Specifications for Clean and Dry Steam.
- ☐ No. 38. Amount of Savings by Using Standard Specification Steam in a Paper Mill.
- ☐ No. 37. What happens when you don't have Standard Specification Steam.
- ☐ No. 36. Concentration in Boilers.
- ☐ No. 34. The Tracyfier in Cement Plants.
- ☐ No. 32. The Physical Side of Concentration in Boilers.
- ☐ No. 28. Blowing Down a Boiler through the Steam Nozzle.

Andrews-Bradshaw Company

536 Fourth Avenue Pittsburgh, Penna.

The grate surface is made up of removable links. Links can be removed and replaced *without disturbing the load on the boiler.*



The Cradle of Power

McClave

Chain Grate **Stokers**

Natural draft and forced draft

for all grades of bituminous fuels

The grate surface is the cradle of power. There, *energy is generated to do work.* There, combustion efficiency is determined.

And it is there where McClave Chain Grate Stokers lead—for McClave has been building grates for over 40 years, and when McClave builds a stoker McClave knows how to build the kind of grate the modern stoker should have.

Whether yours is an electric generating or steam heating plant, McClave Chain Grate Stokers can save you money by burning the fuel more efficiently. This is one place *between the coal pile and the kilowatt* where it is possible for you to save. *Why not do it?*

Write our nearest office for details.

McCLAVE-BROOKS COMPANY

Sole Makers of the Famous McClave Grates Since 1883

SCRANTON, PENNSYLVANIA

DISTRICT SALES OFFICES

NEW YORK 1410 Broadway
ATLANTA 1328 Candler Bldg.
PHILADELPHIA 610 Morris Bldg.
CHARLOTTE, N. C. 406 Clement Ave.
MEMPHIS 808 Dermon Bldg.
DALLAS, TEXAS 307 North Market St.
CLEVELAND 554 Leader Bldg.
ST. LOUIS Syndicate Trust Bldg.
CHICAGO 1510 Conway Bldg.
BUFFALO 333 Jackson Bldg.

Representatives in All Principal Cities

McClave GRATES STOKERS STEAM BLOWERS

McClave COMBUSTION SYSTEMS *for greater economy*

Square dealing built Linde's reputation

IN THE emergencies of the last fifteen years —and there have been emergencies of many kinds—the spirit of a business house has had many opportunities to show itself.

Were the customers' rights protected? Or were excuses delivered instead of materials, and customers left to look out for themselves?

Linde's reputation with its customers during all these years is one of which the company is justly proud. The rights of the customer have always been paramount.

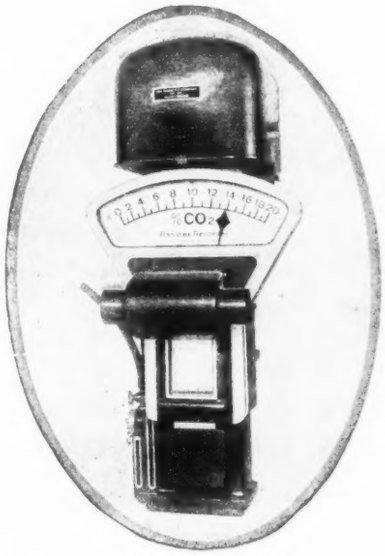
As a Linde customer you are sure of your oxygen supply, not only in times of plenty, but in times of emergency as well. It is guaranteed by 37 Linde plants, 105 Linde warehouses and by the Linde principle of giving the customer a square deal.

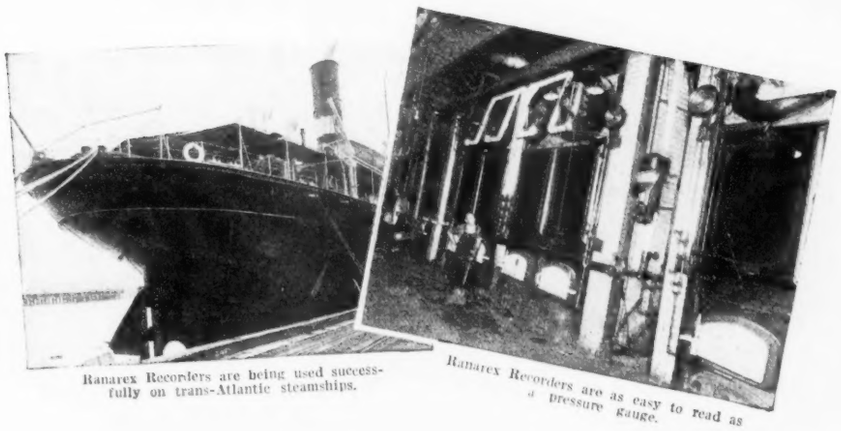
THE LINDE AIR PRODUCTS COMPANY

Manufacturers of oxygen, nitrogen, pyrogen, argon and neon
Producers of helium for scientific purposes

General Offices: Carbide and Carbon Building
30 East 42d Street, New York
37 Plants—105 Warehouses

OXWELDED PIPE FITTINGS are extremely successful and their flexibility recommends them to the average plant man. The Linde Procedure Control on oxwelded pipe fittings gives detailed instructions and is especially valuable on obscure points which enter vitally into the ultimate success of the operation.





Ranarex Recorders are being used successfully on trans-Atlantic steamships.

Ranarex Recorders are as easy to read as a pressure gauge.

So Rugged
They are used on Ships

A Few Prominent Users of Ranarex Recorders

	Number of Installations
U. S. Government Plants	38
Standard Oil Co. of N. J.	33
Cons. Gas & Elec. Co.	23
E. I. Du Pont de Nemours	13
General Motors	11
Columbia Power Co.	9
Standard Oil Co. of Ohio	8
General Electric Co.	8
John B. Stetson Co.	7
Dayton Power & Light Co.	6
Viscose Co.	5
Tampico Electric Co.	5
International Paper Co.	5
Penn. Ohio Power & Light Co.	4
Ohio Public Service Co.	4
Jones & Laughlin	4
The Texas Co.	3
West. United Gas & Elec. Co.	3
Russell Miller Milling Co.	3
Kellogg Co.	3
American Cyanamid Co.	3
Bethlehem Steel Co.	3
Standard Oil Co. of N. Y.	2
Carnegie Steel Co.	2
Anaconda Copper Min. Co.	2
Hammermill Paper Co.	2
American Spiral Pipe Works	2
American Laundry Mach. Co.	2
Ford Motor Co.	2

IT TAKES a good deal of time and engineering skill to keep all the instruments in a boiler room working properly. And if you have an instrument as delicate as the average CO_2 Recorder, your difficulties are doubled.

That is why Ranarex Recorders have come into such widespread use. They determine CO_2 by purely mechanical means, and are so rugged and strong in every part that they will stand up under the most unfavorable conditions. Many of them are operating on ocean-going ships.

In your plant Ranarex will pay for itself out of savings very quickly. Its large 12-inch dial stares out from the boiler front at your firemen every moment of the day, keeping them constantly informed of the exact combustion conditions under the boilers. Leaks in a boiler setting are detected almost as soon as they occur, and draft regulation can always be kept at the point of maximum efficiency.

It will pay you to know more about this simple Mechanical Combustion Indicator. Let us send you our free bulletin. *No obligations—write today.*

Ranarex

The Mechanical Combustion Indicator

The Permutit Company

440 Fourth Ave., New York

Please send me your free booklet "Ranarex—The Mechanical CO_2 Indicator and Recorder."

Name..... *Position*.....

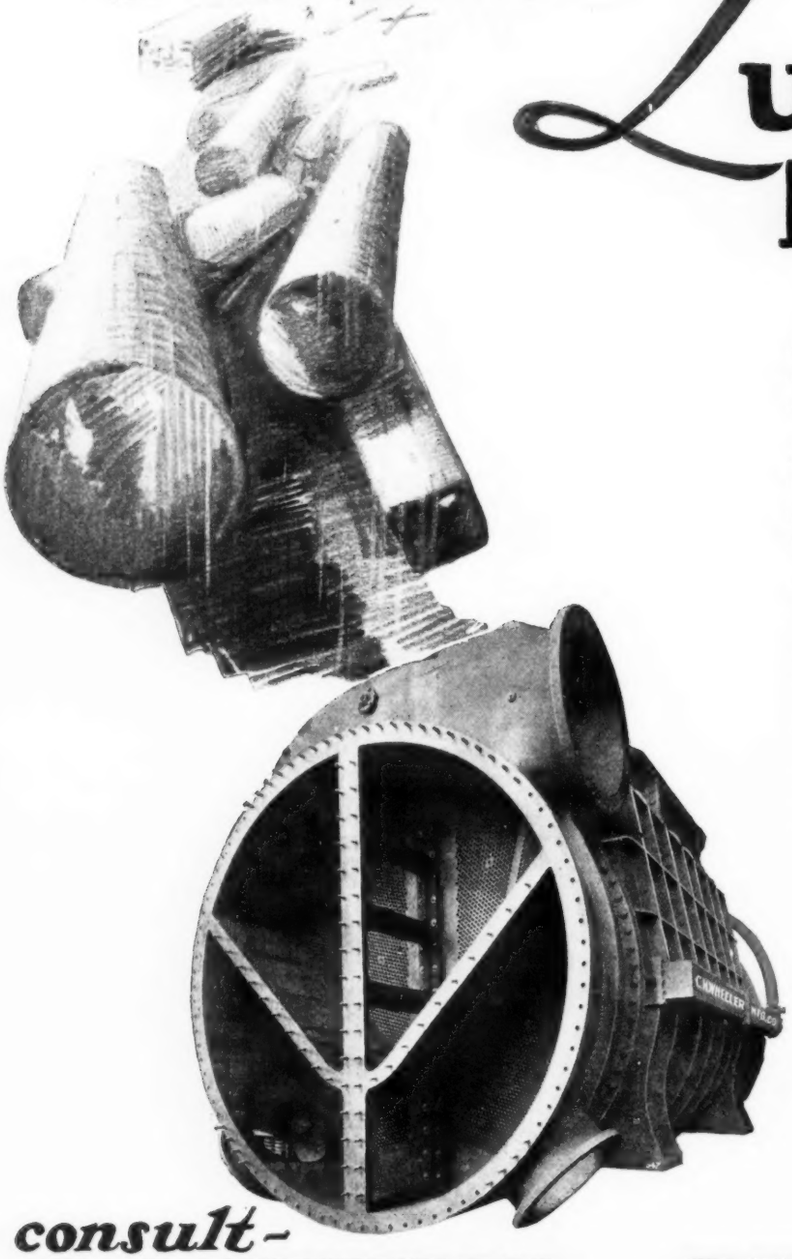
Company .....

Address .....

Branch Offices and Agents in all Principal Cities

Industry consults C. H. Wheeler

for Lumber MILLS -



And here is still another tremendous industry that consults C. H. Wheeler on Condenser Problems—Lumber Mills.

A typical example in this field is the Crossett Lumber Co., at Crossett, Ark., one of the largest lumber concerns in the South.

The Crossett Company wanted expert advice. We studied the job, recommended the best condenser in our long experience for it. The results in high vacuum, low pumping power, maximum return of condensate heat to the boilers, and general reliability were so satisfactory that Crossett has repeated twice on C. H. Wheeler equipment.

We build each condenser for its particular job. We build condensers of all sizes for every class of service. Industry consults C. H. Wheeler—and gets *expert* advice!

C. H. WHEELER MFG. CO.
19th St., Lehigh and Sedgley Aves.
PHILADELPHIA, PA.

consult -
C.H.WHEELER OF PHILADELPHIA
on your condenser problems

How much is 10% of your fuel bill?

—*a Reilly Heater may save it for you*

Your boiler needs these G-R protections

Multiscreen Filter

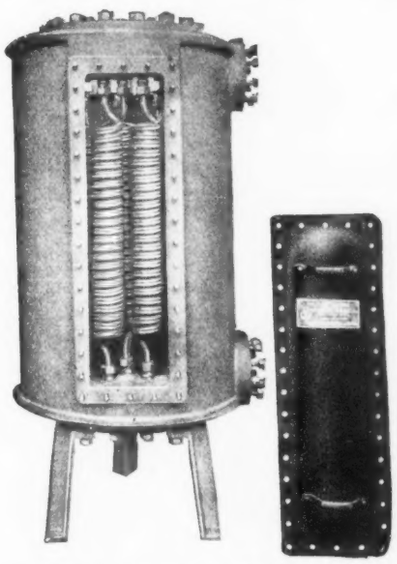
Protects boilers against damage due to oil contaminating the feed water. Will thoroughly remove oil from returned condensed steam from engines, heating systems, etc., and is also suitable for the removal of sand, etc., from water.

Bundy Oil Separator

Takes all the oil out of exhaust steam and *holds it*. The multiple baffle plates effectively stop the oil and then immediately remove the oil particles from the steam path and drop them into the receiver.

Stratton Jr. Oil Separator

A gas washer as well as an oil separator. A curtain of water spray thrown across the path of the entering steam condenses and collects the vaporized oil as well as the liquid oil particles and then the separator throws the oil out of the steam path by centrifugal force.



Your exhaust steam contains hundreds of hidden dollars that are **thrown** away when the exhaust is allowed to go to waste.

By passing this exhaust through a Reilly Heater you can transfer most of its heat to the water for boiler feed, domestic service, or process work.

For example, every 11 degrees increase in feed water temperature saves about 1% of fuel. In *over twelve million horsepower of boilers*, Reilly Heaters are reducing fuel costs upwards of 10% through this particular application, and are effecting similar savings in heating water for other services.

You can find out the advantages, details of construction and possible application of the Reilly Heater to your plant by simply filling in and returning to us the coupon at the bottom of this page. No obligation, of course.

Mail the coupon today

The Griscom Russell Company, Dept. A, 285 Madison Ave., New York

Philadelphia	Chicago		St. Louis	San Francisco
Boston	Cleveland		New Orleans	Los Angeles
Rochester	Detroit		Houston	Seattle
Pittsburgh	Milwaukee		Dallas	Denver
Columbus	Minneapolis		Atlanta	Salt Lake City
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Please send information on
Reilly Water Heater
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P12-28-26

Elesco Superheater and Wickes Boiler Arrangement at Colorado Springs plant.

The Municipal Plant, of Colorado Springs, Colorado

has three Wickes cross drum boilers equipped with Elesco superheaters to supply steam at 100 deg. superheat to two turbines.

Elesco superheaters are designed to meet the individual requirements of each installation by experienced engineers with a thorough knowledge of fuels, combustion and furnace design. Each factor is duly considered to bring about the desired final steam temperature.

Interesting bulletins describing Elesco superheaters as installed in any make of boiler sent on request.

Put your problem in superheat up to our Engineering Department for solution.

THE SUPERHEATER COMPANY

17 East 42nd Street, NEW YORK

Peoples Gas Bldg., CHICAGO — **Union Trust Bldg., PITTSBURGH**

ATLANTA, BIRMINGHAM, BOSTON, CHARLOTTE, DENVER, SALT LAKE CITY
HOUSTON, KANSAS CITY, MEMPHIS, NEW ORLEANS, ST. PAUL, SAN FRANCISCO

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SMOOTH-ON No 3 will keep those big joints tight!

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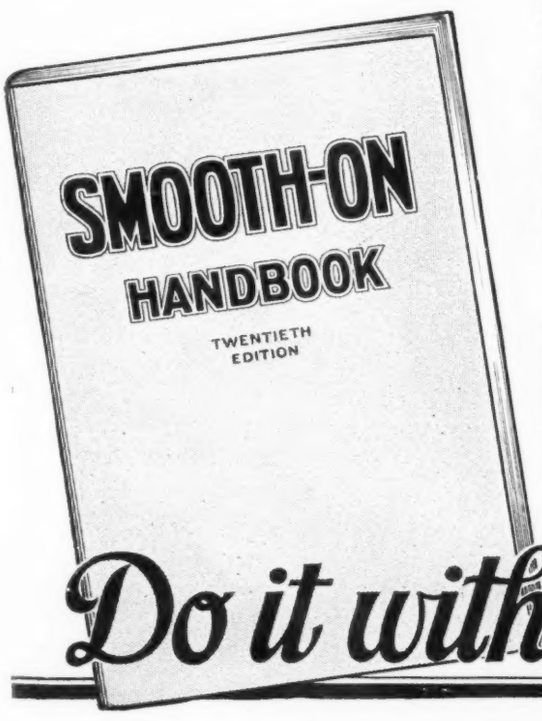

PAINTING SMOOTH-ON No. 3 onto the gasket of every flanged joint you make is a sure cure for the leak nuisance because SMOOTH-ON No. 3 is exceptionally well able to hold at any pressure and temperature and under the severest changes of either or both.

SMOOTH-ON No. 3 packs all voids and surface irregularities with a metallic filler that cannot dry or blow out, crack or loosen in any way until the joint is intentionally opened.

Use it also on screw threads and the results will be all you could ask on any joint that must hold against superheated or saturated steam, water, hot oil, air or even gasoline.

Get SMOOTH-ON *No. 3 in 1- or 5-lb. cans from your nearest dealer or if necessary from us direct.*

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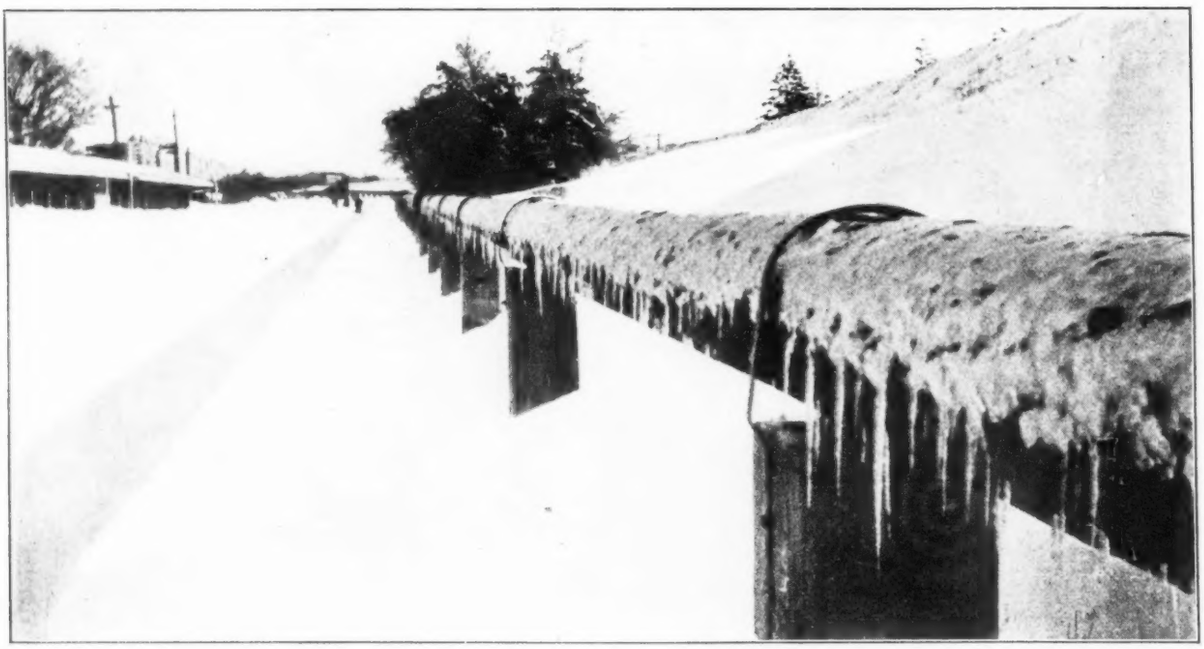
Do it with **SMOOTH-ON**

This is a high pressure STEAM line, not a REFRIGERATOR line



Silent but *Conclusive* Evidence of the High Insulating Value

Keasbey & Mattison Company's "Featherweight" 85% Magnesia Pipe Covering

The above unretouched photograph of an 8 inch steam line nearly a mile long carrying high pressure steam, at a prominent New England Manufacturers plant, showed an actual heat loss of less than 3% in a 12 hour test with outside temperature of 25° F. (7° below freezing).

This wonderful performance was due to the fact that the line was insulated with Keasbey & Mattison Company's "Featherweight" 85% Magnesia Covering, applied in two layers each 1½ inches thick, with staggered joints and protected on outside with roofing paper.

We shall be pleased to send to any engineer or factory owner the full story of the above test with construction data, if you will ask us for our circular—"Long Steam Line Efficient at High Pressure."

This is without obligation. Therefore write

Keasbey & Mattison Company

Ambler, Penna.

or Branch Offices as follows:

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Southwestern Distributors: R. V. Aycock Company, Kansas City, St. Louis, Tulsa, Houston
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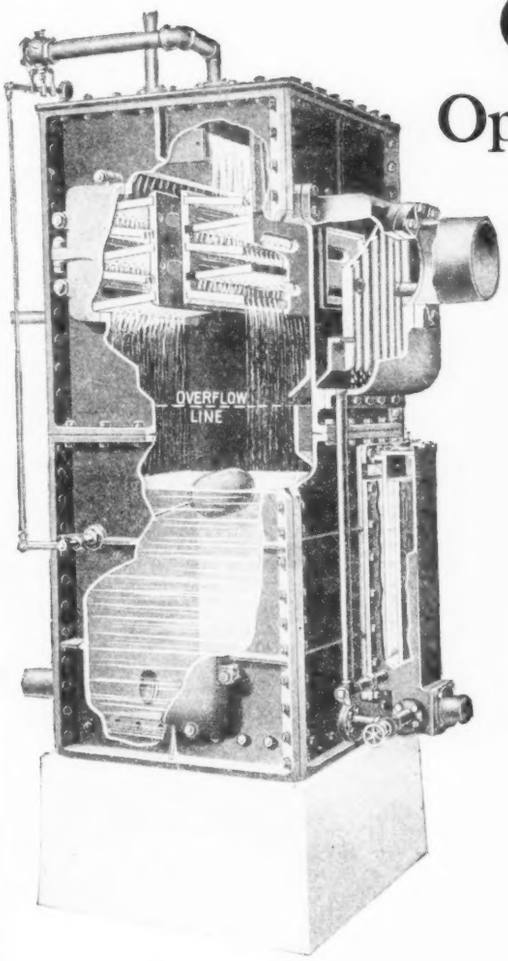
"REG. U. S. PAT. OFF."

"REG. U. S. PAT. OFF."

COCHRANE
Open Feed Water Heater



IN Cochrane Open Feed Water Heaters, the steam comes into direct, actual contact with the water, which is heated to the steam temperature. The steam is condensed and mingles with the water, saving the heating of an equal amount of raw make-up water. About 1% of fuel is saved for each 11 degrees Fahr. added to the temperature of the water, the total saving amounting to as much as 15% where the water is received at a low temperature. Engines, pumps, etc., exhausting into a Cochrane Heater are thermally more efficient than the best condensing turbine, because, except for radiation, all of the heat not converted into power is returned to the boilers. Boilers fed with hot water steam easier than boilers fed with cold water, since part of the work of heating the water has been done in the heater.

The heater also serves as a hot water return tank and as an automatic cold water regulator. The heating of the water by spraying through the steam bath drives off air and other gases and protects the boilers against oxygen corrosion. Heating also breaks up carbonate of lime in the heater. Where the water contains permanent hardness, the Cochrane Hot Process Water Softener, in which suitable chemical treatment is combined with heating, is recommended.

The shell of the Cochrane Heater is constructed of heavy cast-iron plates. Internal parts are of cast iron, brass or bronze. The heating trays are removable through suitable cast-iron doors.

The admission of raw water is controlled by a substantial copper float operating a balanced valve. Heaters intended for operation at atmospheric pressure have water-sealed over-flow traps, which also receive the drips from the separator. Heaters intended for operation under back pressure are fitted with float traps.

For large capacities, especially where head room is limited or where high back pressures are to be carried, the horizontal cylindrical form of heater is recommended. Extra water storage capacity can be provided in the shell of the heater itself or in an independent tank, as most suitable.

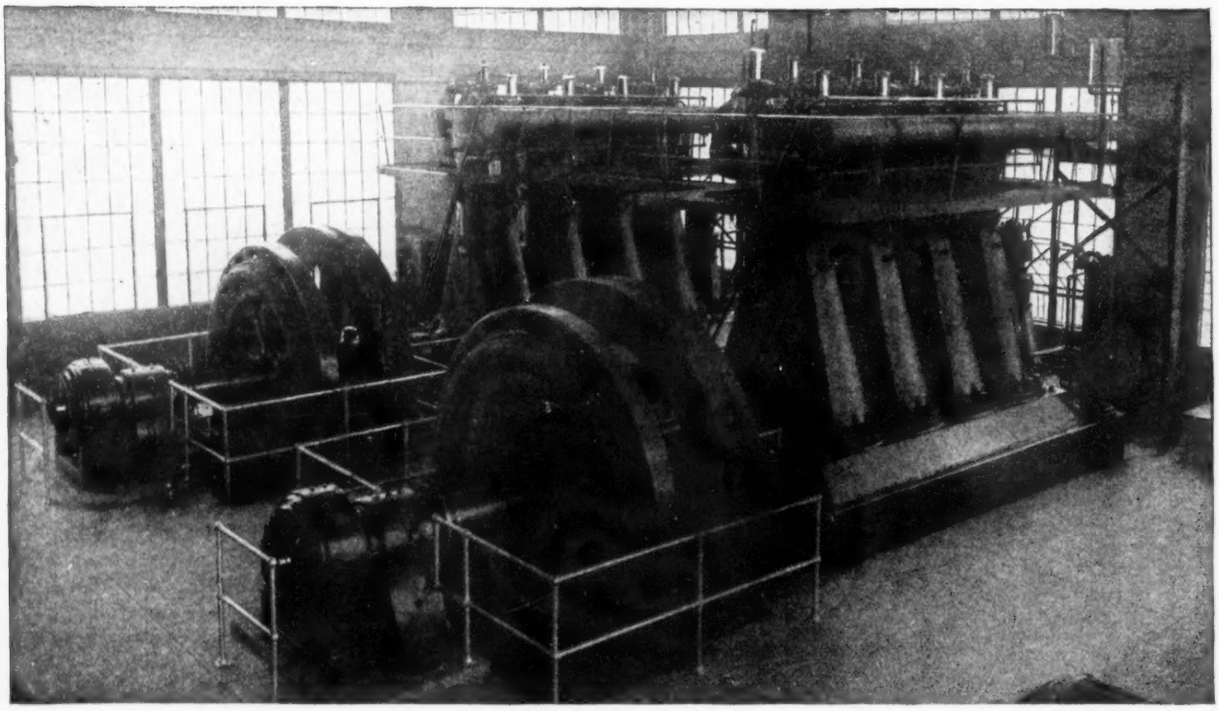
Some Users of COCHRANE HEATERS

B. F. Goodrich Company, Akron, Ohio.
Bethlehem Steel Company, Redington, Pa.
Cudahy Packing Company, Sioux City, Iowa.
Calumet & Hecla Mining Company, Calumet, Mich.
E. I. DuPont de Nemours & Company, Wilmington, Del.
Illinois Steel Company, Gary, Ind.
International Paper Company, Bellows Falls, Vt.
John A. Roebling & Sons Company, Trention, N. J.
Procter & Gamble Company, Macon, Ga.
U. S. Naval Proving Ground, Indian Head, Md.
American Woolen Company, Saranac Mills, Blackstone, Mass.
War & Navy Office Building, Washington, D. C.
American Sheet & Tin Plate Company, Chester, W. Va.
Coca-Cola Company, Atlanta, Ga.
Champion Paper Company, Carthage, N. Y.
General Electric Company, Lynn, Mass.
Pratt & Whitney Company, Hartford, Conn.
Pittsburgh Plate Glass Company, Ford City, Pa.
Palmolive Company, Milwaukee, Wis.
Standard Oil Company, Chicago, Ill., Jersey City, N. J.
Union Stock Yards, Chicago, Ill.

COCHRANE CORPORATION

17th and Clearfield Streets, Philadelphia, Pa.

352



Two 500-b.hp. McIntosh & Seymour Diesel Engines driving 437-kva. 60-cycle alternators at Nogales, Ariz. These units furnish current for general lighting and power purposes including irrigation. The transmission lines extend to mines and mining camps in the mountains nearby, and even with these expensive lines, the efficiency of the station admits of furnishing power very profitably to both the owner and the mines. For "off-peak" load, the station serves a large motor-driven ice machine furnishing cold storage facilities and ice for general use and icing refrigerator cars.

Diesel Engines do perfect work with low-grade oil

McINTOSH & SEYMOUR units will operate on any crude or semi-refined oil which is reasonably free from water, sulphur and dirt and is fluid enough to feed.

As a typical example, the above engines use only California oil containing about 50 per cent asphalt, and so heavy as to require preliminary heating before it can be pumped. Notwithstanding this, the cylinders, pistons and rings show no deposits and require no cleaning beyond what is given at the twice-a-year examinations this type of engine should have under any conditions.

Upon test by the purchaser's consulting engineer after several months' operation, the fuel consumption was shown to be at the rate of over 14 kw.-hr. per gal. and the lubrication was accomplished with less than 5 gal. per 24 hr. for both engines for all purposes.

If you hesitate to adopt Diesel power because of the quality of fuel available, let our Engineers show you how and why full benefits can be obtained with practically no difficulty. At least ask for literature.

BY INVITATION MEMBER OF

NEW YORK, U.S.A.

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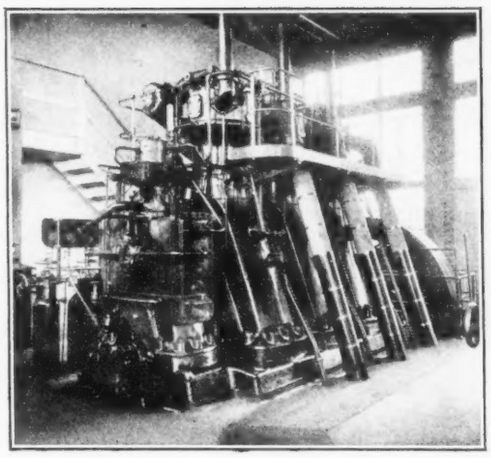
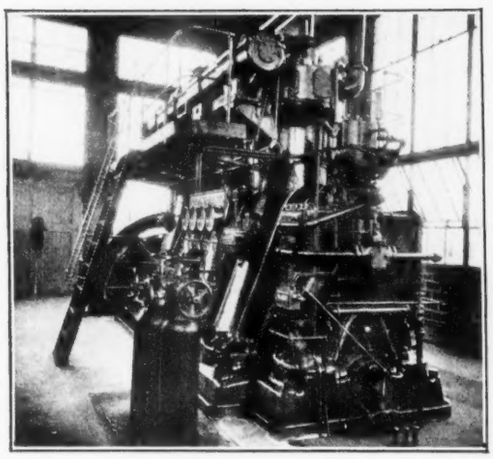
McINTOSH & SEYMOUR DIESEL ENGINES

FULTON DIESEL

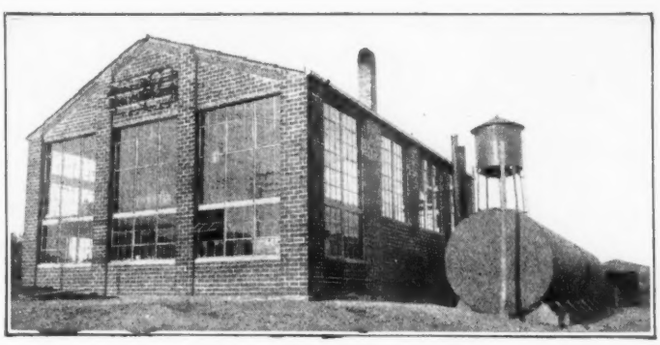


300-b. h. p. Fulton-Diesel direct-connected to Generator

Cuts Fuel Bill 81 Per Cent



400-b. h. p. Fulton-Diesel direct-connected to Generator



Hawarden, Iowa, Municipal Plant

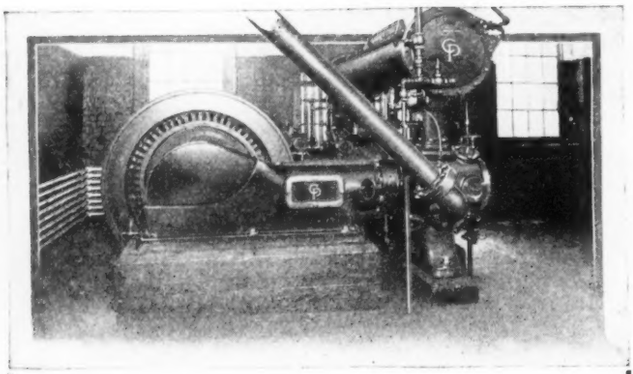
THE City of Hawarden, Iowa, operated its Fulton-Diesel plant during the year ended March 31st, 1926, at a cost of $4,142.18 for fuel oil. The annual coal bill for the old steam plant which the Fulton-Diesel equipment replaced averaged $22,239.98 during the preceding four years,—or a saving in favor of the Fulton-Diesel of $18,097.80 per annum.

In fact, the entire cost of operating the Fulton-Diesel plant for the year, including all overhead charges, depreciation allowance, insurance, etc., was slightly more than one-half the amount of the steam plant's coal bill alone.

Fulton-Diesel installations have a history of economical and dependable operation. We welcome the opportunity of giving you complete details of the many distinctive features of the design which has made this unit so outstandingly successful. May we send you a copy?

FULTON IRON WORKS COMPANY, St. Louis, U. S. A.

Successful engine builders for over seventy years.



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An Investment in Shop Economy

BACK of the innumerable daily jobs which call for the use of compressed air, stands the compressor, with its ability to increase or decrease production costs.

Hundreds of manufacturers, contractors and railway shops are obtaining the greatest possible shop economy through the use of Chicago Pneumatic Compressors.

With such features as Simplate Valves, automatic regulation and self-lubrication, CP's represent an investment in shop economy and dependable, economical service year after year.

Simplate Valves make these Compressors reliable even in 24-hour-a-day service. With low inertia to overcome, the lift of these discs is straight and uniform, affording a large effective area with small clearance. That is why these machines deliver the maximum volume of air with minimum power consumption.

CP Stationary and Portable Compressors are supplied in steam, oil, belt and direct motor driven types to meet all compressed air requirements. Write for Bulletins containing full information.

C-214½

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Diesel Oil Engines *Heat Transfer Apparatus*
Complete Fuel Oil Burning Installations
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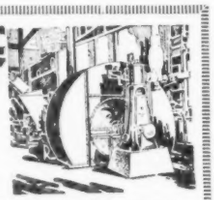
HIGH SPEED ENGINES

If you require a sturdy, economical steam engine, investigate the Clarage Type V. Will operate at high speeds with safety. Ruggedly built, self-oiling, with all moving parts enclosed. *Write for Catalog 61.*



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Over 600 in Service
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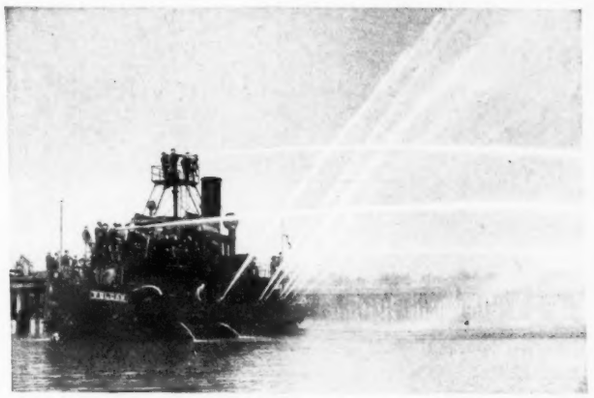
LOMBARD DIESEL ENGINES

100 TO 600 H.P.

THE LOMBARD GOVERNOR CO. ASHLAND MASS.

ACCEPTABLE FOR FIRE PUMPS

In fact, the underwriter's specifications were written years ago, largely from Sterling Engine details (and no engine is today so highly developed). Since then in the Jacksonville, Fla., Norfolk, Va., Fire boats, at Oakville, Canada, and numerous other cities, Sterling engines have proven they can be started instantly and put out fires.



The VULCAN contains 4 six-cylinder STERLING engines on Midwest centrifugals running at 1200 revolutions. The development of STERLING engines for pumping service made this boat possible.

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High Duty
Internal
Combustion
Engines

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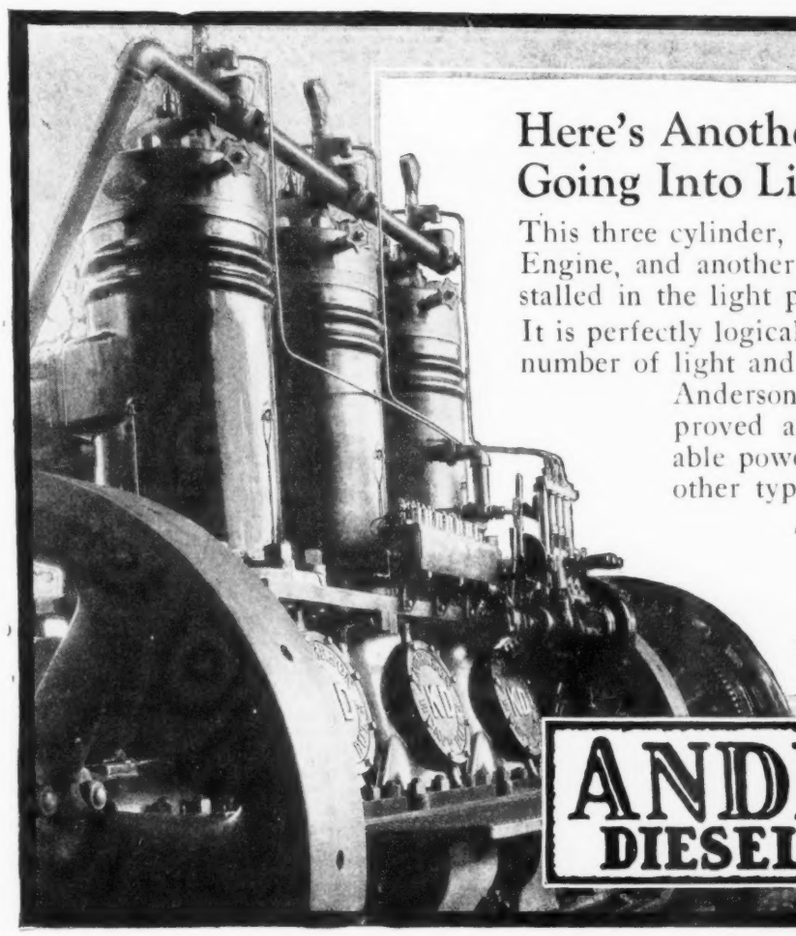
Single units to 250 B.H.P. load.
1200 revolutions, $20 a horsepower.



Here's Another Anderson Going Into Light Plant Service

This three cylinder, 150 H.P. Anderson Diesel Engine, and another just like it, are being installed in the light plant at Manchester, Ohio. It is perfectly logical that an increasingly large number of light and water plants are choosing Anderson Engines — they have proved ability to produce dependable power at a lower cost than any other type of prime mover.

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ANDERSON DIESEL ENGINES

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Unaflow
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Single Valve

All Makes of Engines
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For medium and high pressures

ESPECIALLY suitable for large power plants. Steel construction throughout. Straight tubes. All hand-holes elliptical, their covers internal and removable through their own openings. Unrestricted circulation, permitting forcing of fires with safety and economy.

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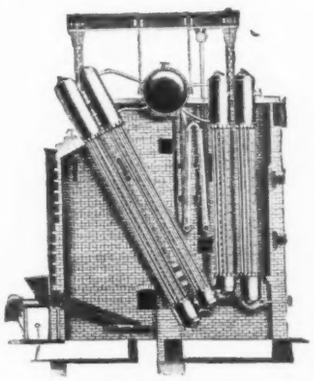

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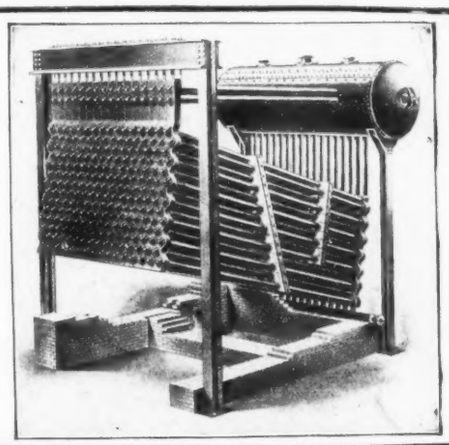

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ALL TYPES, SIZES, PRESSURES

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Made in sizes to 2500 hp. and pressures to 450 lbs.

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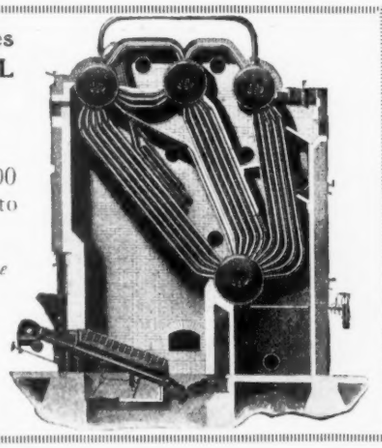

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Established 1890

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Vertical Four Drum and Horizontal Cross Drum Water Tube Boilers
In units of from 200 to 3000 hp. and for pressures up to 400 lbs.

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MAIN OFFICE DU BOIS PA. OFFICES IN THIRTY CITIES
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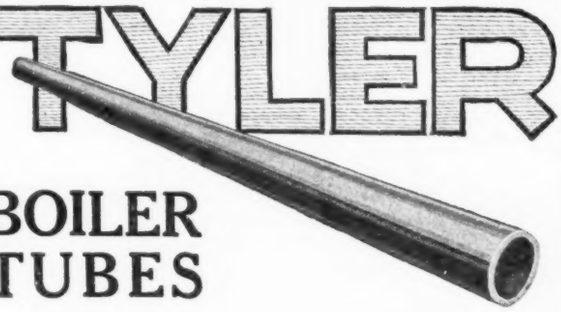

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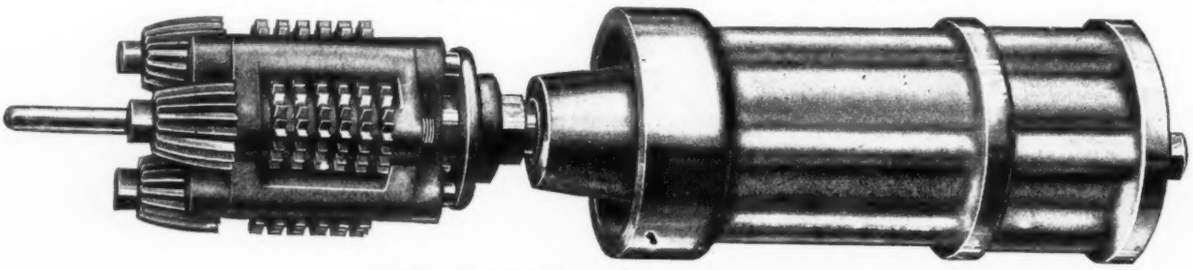

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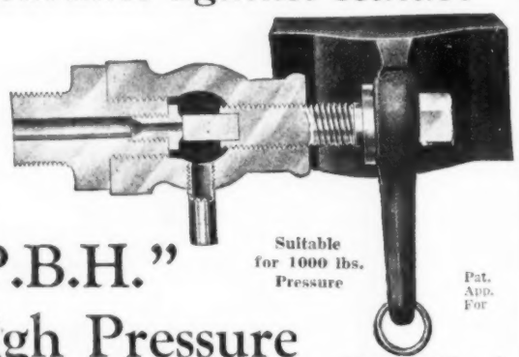

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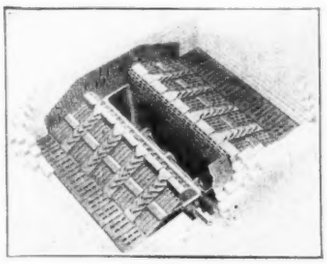

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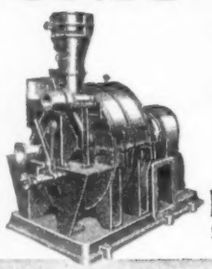

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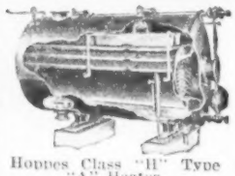

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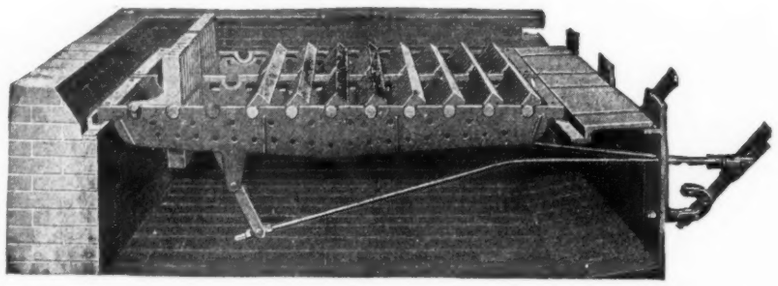
Rocking and Dumping Grates



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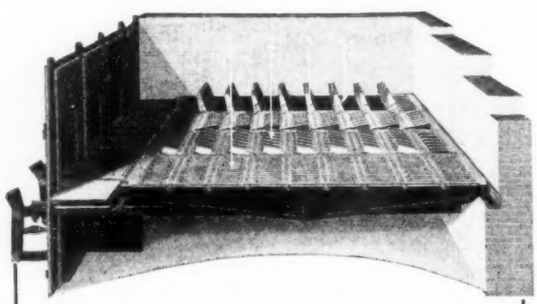

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5. No warping or bending of grates.
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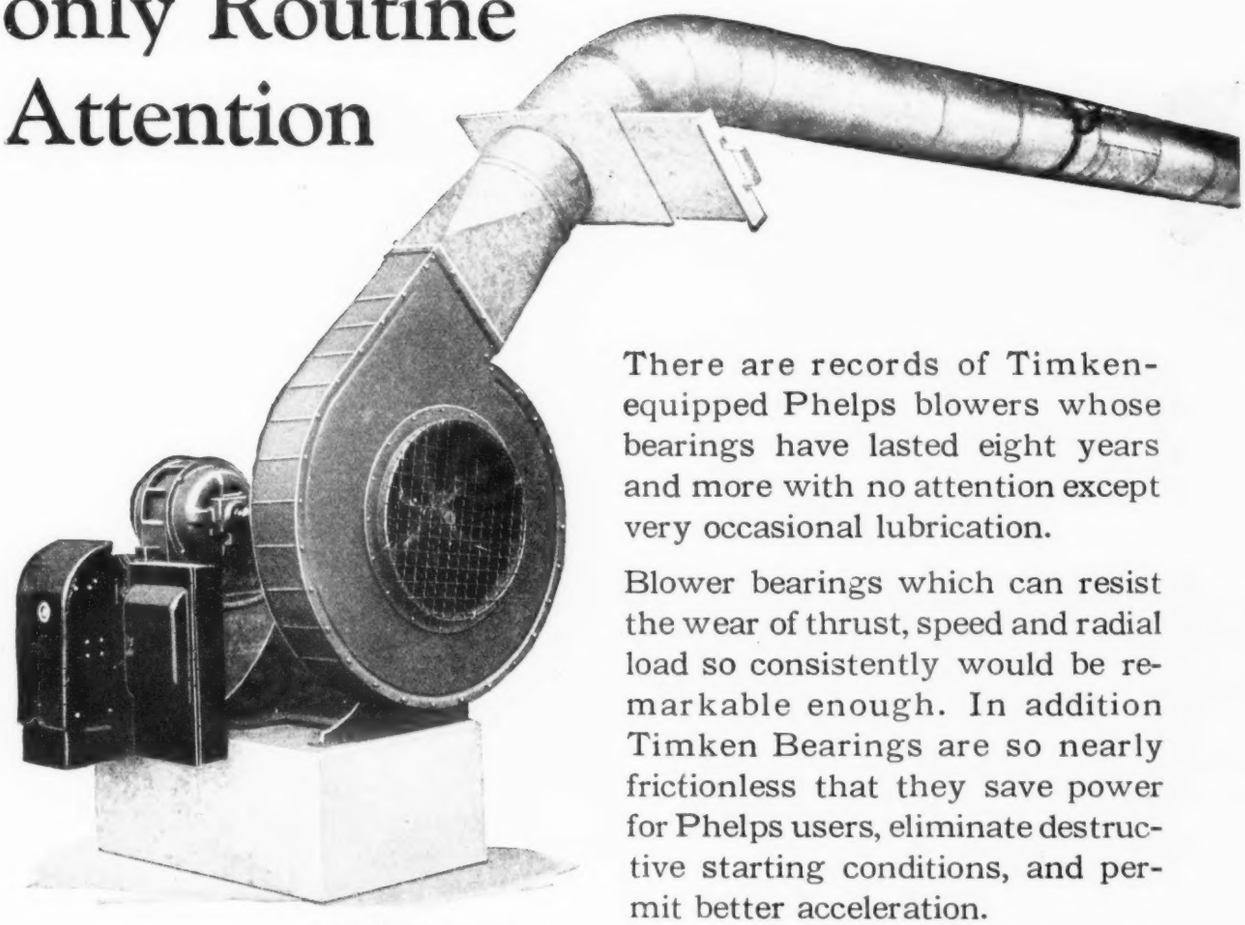

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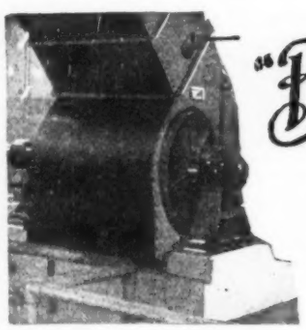

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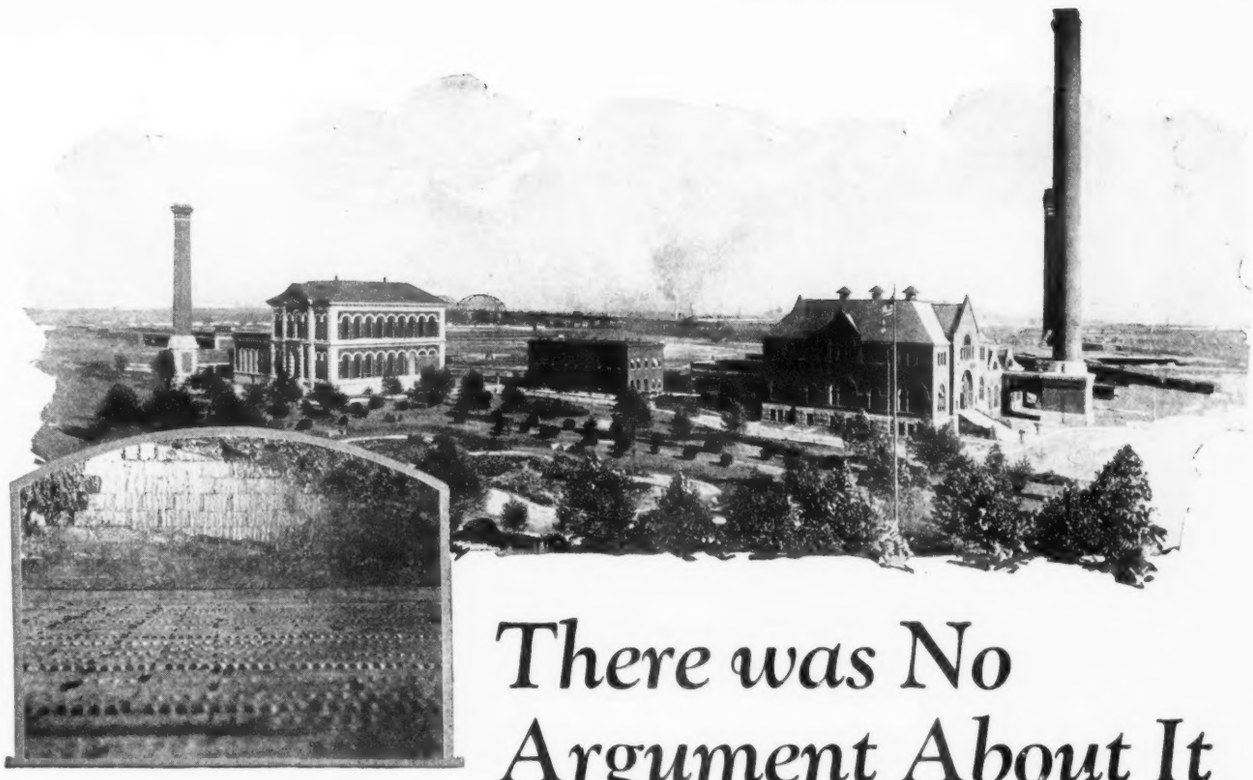

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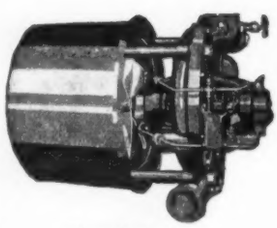
For Every Boiler Stokered or Hand-Fired



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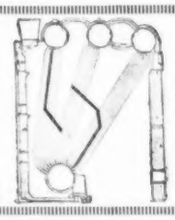

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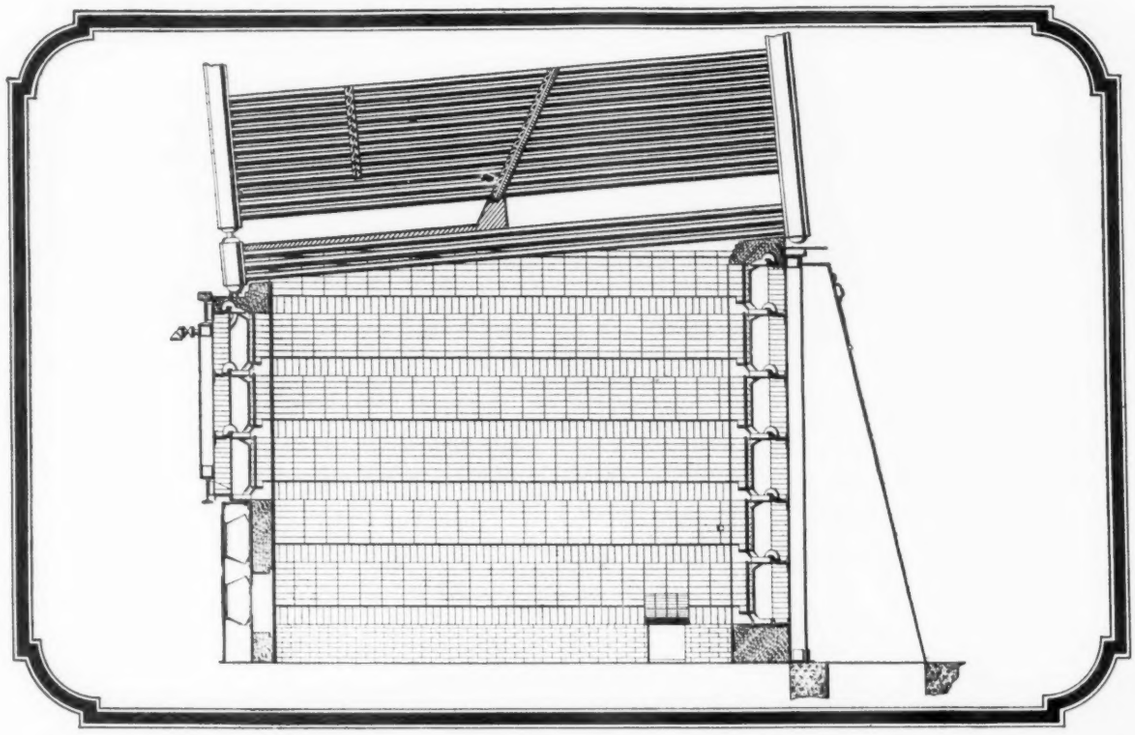

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For Oil Fired Furnaces

In oil fired furnaces where the high ratings and high temperatures ordinarily cause heavy refractory maintenance the Detrick Sectional Supported Wall has proven a genuine success. The longer life of this modern furnace lining has made possible a saving in a very short time.

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DETRICK *Sectional Supported* WALLS

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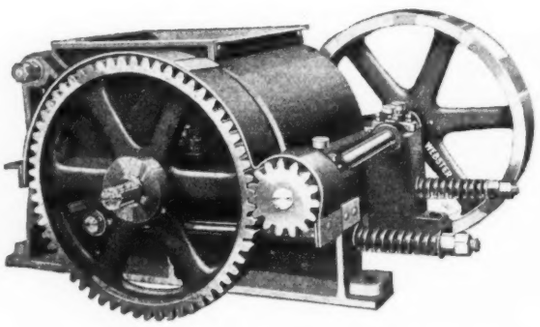
Simple in design.
Well proportioned.
Ruggedly constructed.
Withstands severe service.



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Can be adjusted to change size while in operation.

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Coal and Ash Handling Equipment

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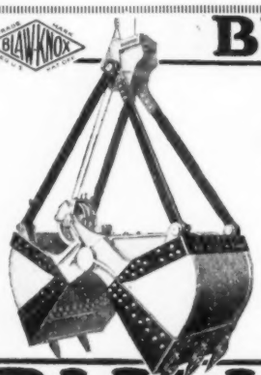

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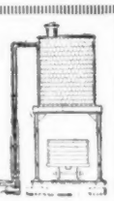

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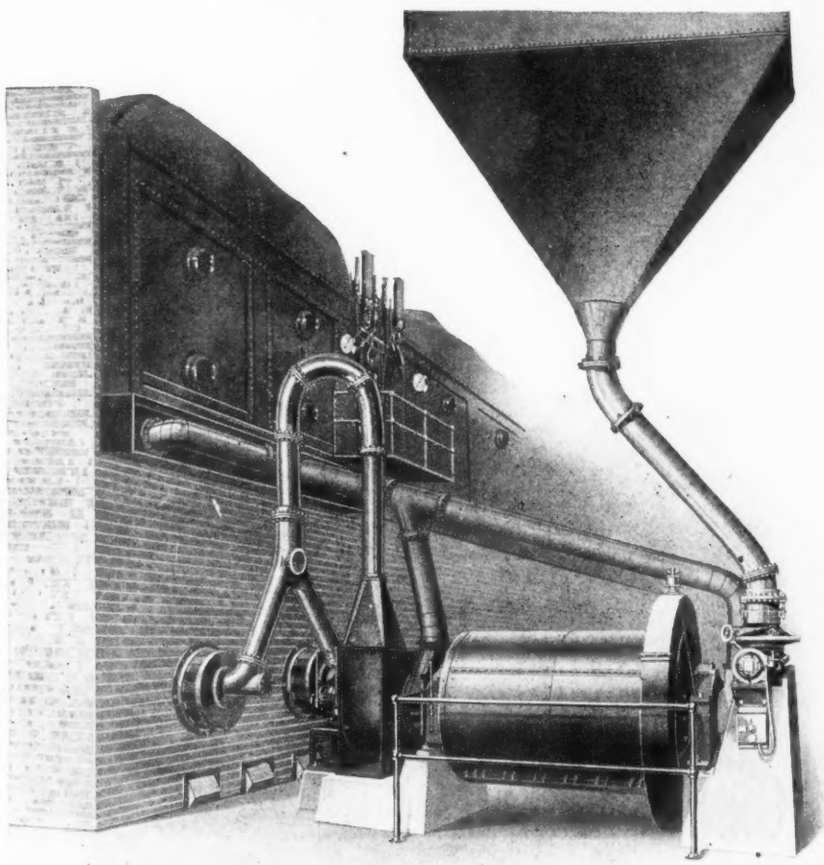

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Due to finer pulverization than can be obtained with any other type of pulverizer.

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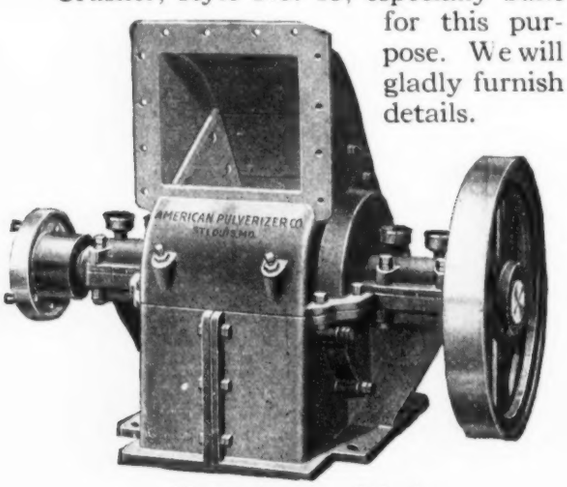

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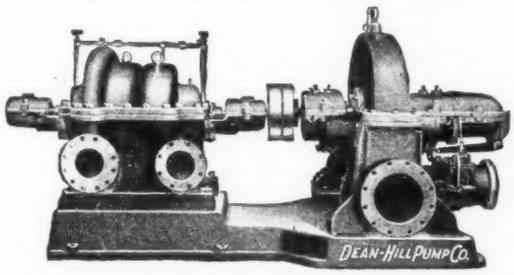

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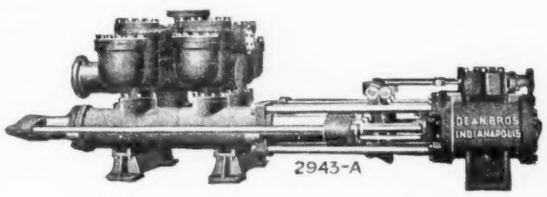

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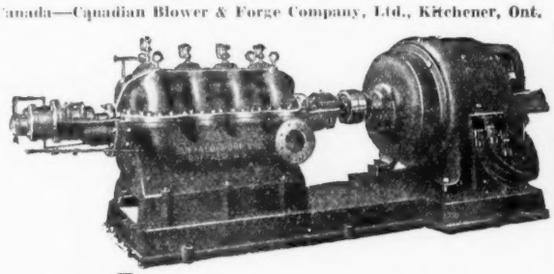
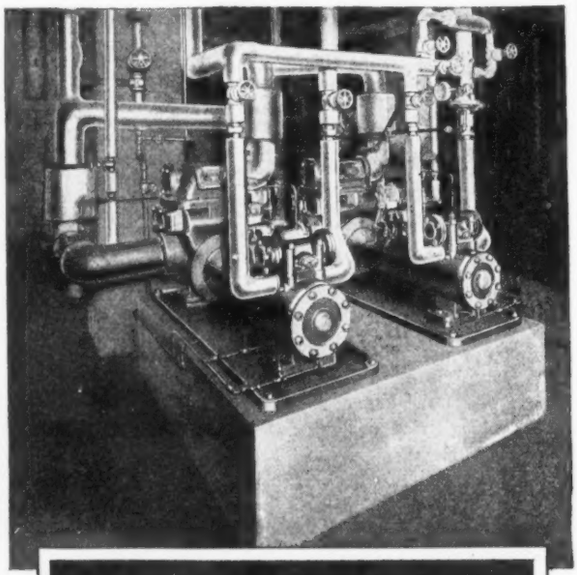


"Buffalo" Boiler Feed Pumps

WORTHINGTON

Worthington Simplex Pumps
in Boston City Hall Annex



Preferred by many - because of its simplicity

THE simplex steam pump has the advantage of being exceptionally simple in construction, of great reliability and free of any tendency to short stroke.

Once started it will keep on pumping with the same regular, rhythmic movement until the steam is shut off.

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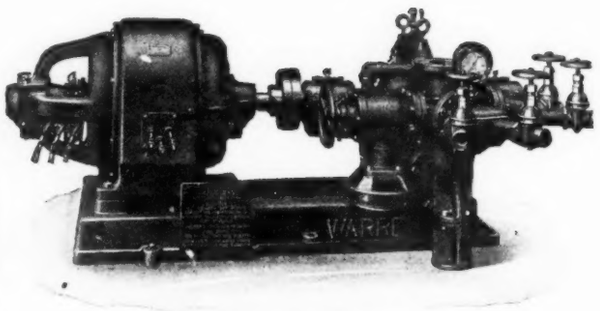

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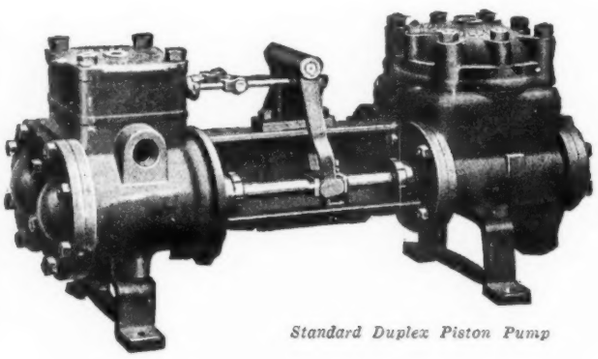
If you judge pumps on the basis of cost per year, Warren Pumps are *your* kind of pumps. Ask us for Bulletins covering pumps for any or every service in your plant.



Standard Duplex Piston Pump

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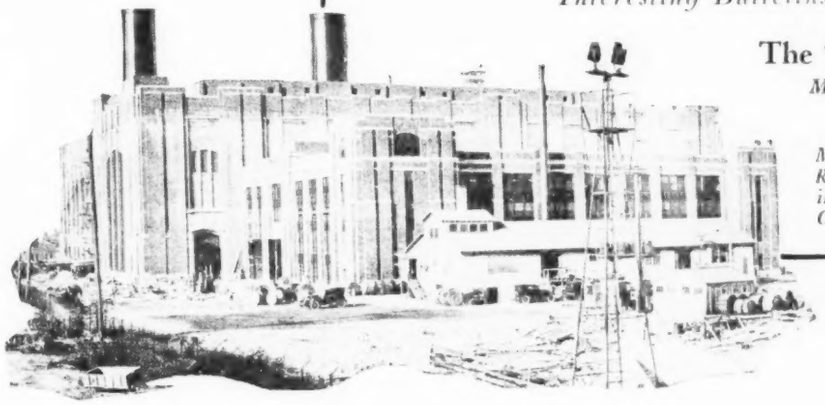
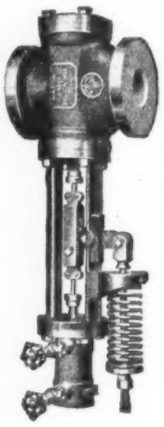


Crawford Avenue Station of the Commonwealth Edison Co., Chicago, Ill.



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Specially designed for use on boiler feed pumps to maintain the right pressure in the feed lines to the boilers. It is backed by the efficiency test given every Mason Regulator and the accumulated experience of this company's forty years of specialization in pressure control.

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Mason Regulators

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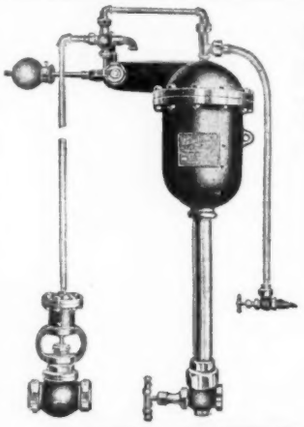
Boston, Mass.



Why Put Up With Out-of-Date Hand Regulation of Boiler Feed?

You can never hope to attain maximum economy and efficiency with it. Between high water and low water your profits will continue dribbling away.

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Provide automatic mechanical regulation that can be depended upon to keep the water level at middle gauge. They hold the water level at a fixed point, under all operating conditions and at all boiler loads.

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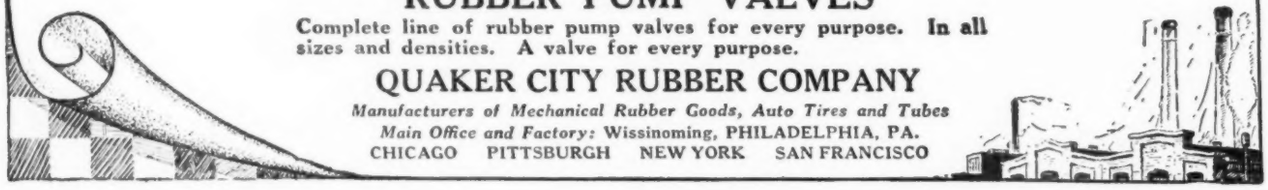

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In use all over the world

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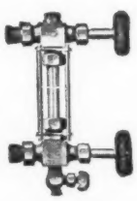

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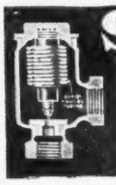

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The inverted submerged principle gives:
Greater capacity than any trap of equal size. Self-scrubbing. Cannot pass steam, action quick and positive. Non air-binding. Small size. Low cost.

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GENUINE NASON STEAM TRAPS
KEEP UPKEEP DOWN

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Steam Specialty Specialists Since 1841

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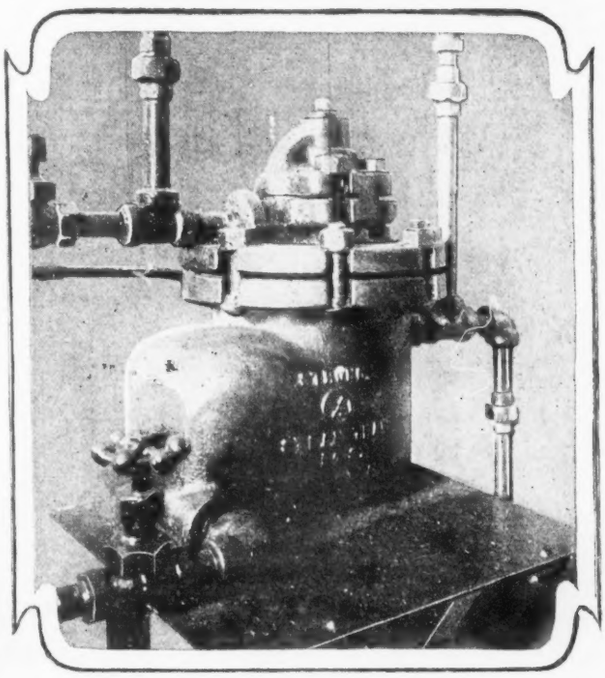
Steam Traps *are far above the ordinary*



TO THE MAN who thinks a trap is just a trap—an investigation of Strong Steam Traps and their performance in actual service will prove to be a revelation.

Our Guarantee that Strong Steam Traps will remain tight for one year without attention is made possible only because both the valves and the seats are made of ANUM-METL. This is a special alloy, which is extremely tough and wear-resisting.

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Strong Steam Traps can be tested right in service by opening a globe valve.

Semi steel bodies for pressures up to 225 lb. and temperatures to 388 degrees.

Cast steel bodies for greater pressures and higher temperatures.

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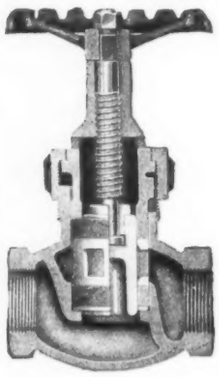

Piston valves have these advantages

Easy operation—no wire drawing—absence of leaky seats.
Long life—close regulation—positive shut-off.

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(KLINGER PATENTS)
can be supplied in
bronze, cast iron and forged steel for steam, water, oil, gas, etc.

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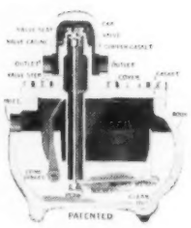
See our Ad. on page 64

The GENUINE **Squires** STEAM TRAP



gives the utmost in service on steam, air or gasoline.

May we send Catalog C-9 giving complete information?

The C. E. SQUIRES Co., Cleveland, O.

Regulating Valves for Every Service

On Which Do You Want Information?

- ☐ Feed Water Regulators
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- ☐ Float Valves
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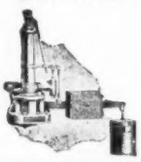
- ☐ Thermostats
- ☐ Balanced Valves



Atlas Valve Co., 289 South St., Newark, N. J

POWER WATTS PLANT UTILITIES LAWRENCE, MASS. ESTABLISHED 1874

Reducing Valves
Pump Governors
Damper Regulators

Send for free copy of Watts Steam Flow Chart and Capacities of Watts Reducing Valves.

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Morehead Back to Boiler → More Power
SYSTEM

Steam that circulates freely through dry lines delivers its utmost power. Maintain this condition with a Morehead Back-to-Boiler System that drains the lines of condensation and returns it hot to the boiler.

Morehead Manufacturing Company
Dept. PM., Detroit, Michigan
(87)

POWELL VALVES
The Wm. Powell Co. Cincinnati, Ohio

BUNDY STEAM TRAPS
newly designed
Separating
Boiler Return Three Valve Pumping
Write for information
BUNDY STEAM TRAP CO., Nashua, N. H.

They remain tight

You can depend upon the maintained efficient operation of

NICHOLSON
Expansion Steam Traps

They have no moving parts. Open wide when water of condensation collects and close instantly when steam comes in contact with the center tube. No liquid or gas. The tube is made of a patented alloy having an exceptionally high co-efficient of expansion. It is the sole motive force of the trap. Can be used in any position. Write for Bulletin. A 30 days' free trial allowed.

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Return Traps *Lifting Traps* *Vacuum Traps*
Separating Traps

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ELLIS STEAM TRAPS ~ TILTING AND BUCKET TYPES ~
There is nothing to equal their simple and reliable operation
ELLIS DRIER CO. 1225 SO. TALMAN AVE. CHICAGO, ILL.

VALVES *of* LASTING SERVICE

Hovalco

the valve that set new standards for safe, tight blow-off service

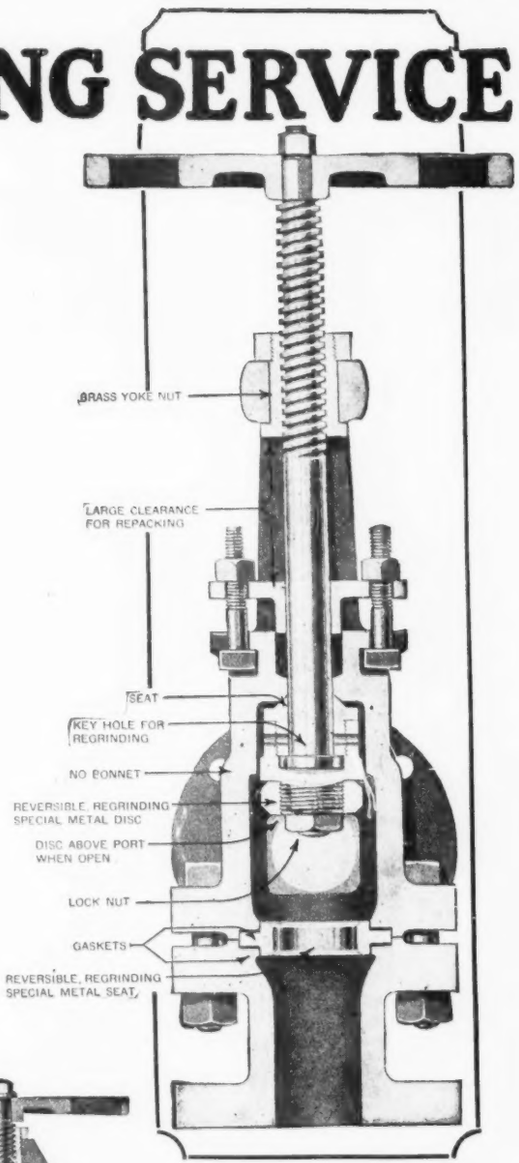
SAFETY is a certainty when you put Hovalco Blow-Off Valves back of your boilers—but safety is not enough in these days of high fuel cost and close checks on the B.t.u.'s!

That's why from their more than a generation of experience in valve building for all kinds of plants and all kinds of services, Homestead engineers designed the Hovalco to give the utmost durability, in leak-tight, trouble-free blow-off service.

Today, many years and many installations have proved Hovalco's mastership over all the usual difficulties of extremely vital and difficult valve service!

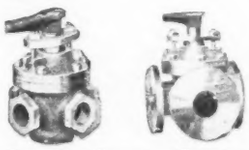
Study the diagram. Note the Reversible, Regrindable and Renewable features—a valve that lasts the lifetime of boilers on which it is installed.

Homestead Semi-Steel—tougher and more closely grained than all-iron—gives it strength and endurance. Monel metal valve seat and disc cannot corrode. Also made of cast-steel for higher pressures.



HOMESTEAD
Quarter Turn Valves

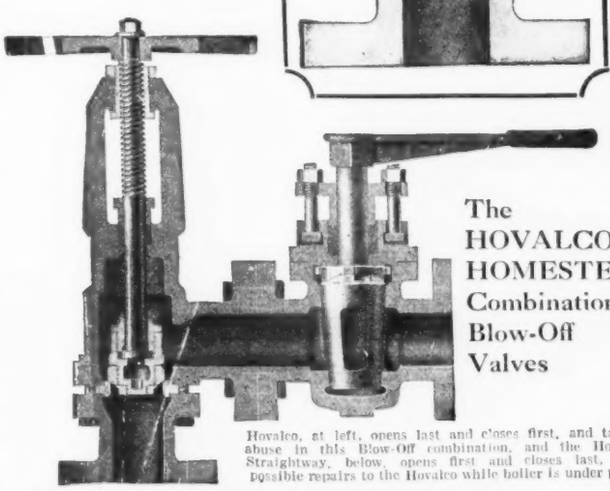
Straight-way Valve as used in Hovalco Homestead Combination.



Four-Way Homestead Quarter-Turn Valve at Left, and Three-Way at right.

With the Homestead Quarter-Turn Valve ahead of it, the Hovalco forms the ideal combination for boiler blow-off and meets all requirements of the A.S.M.E. Code and State Laws.

Consult our engineering department. Catalogue showing the correct size and type of valve for practically every valve service sent free on request.



The HOVALCO HOMESTEAD Combination Blow-Off Valves

Hovalco, at left, opens last and closes first, and takes the abuse in this Blow-Off combination, and the Homestead Straightway, below, opens first and closes last, making possible repairs to the Hovalco while boiler is under pressure.

Homestead Valve Manufacturing Company, Homestead, Pa.

HOMESTEAD

PRODUCTS: *Quarter Turn Valves—Straight-Way Three-Way Four-Way Types—Full Round-Way Valves—Cast Steel Refinery Valves———Lubricated Valves—Hovalco Blow-Off Valves—Protected Seat Globe Valves B & O Pat.—Protected-Seat Hydraulic Operating Valves*

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The LIBERTY VALVE OPERATOR
insures Safety in remote valve control.
Bulletin P-267
LIBERTY ELECTRIC CORPORATION, Stamford, Conn.
NEW YORK DENVER BOSTON PITTSBURGH DETROIT CLEVELAND

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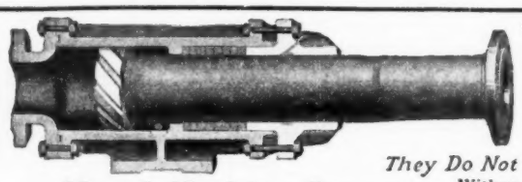
Steel, Iron and Brass Valves
for every power plant purpose and pressure
Write for Catalog.
The Kennedy Valve Mfg. Co., Elmira, N. Y.
New York Boston Chicago San Francisco

MOGUL
Double-End-Guided EXPANSION JOINTS



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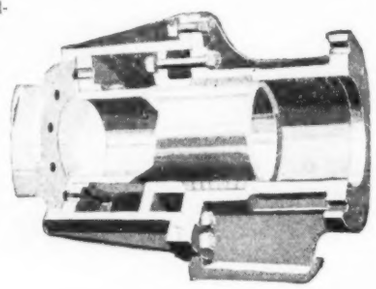
They Cannot Buckle—
The Double Guided Sliding Surfaces of
HOWARD Guided Expansion Joints
maintain perfect alignment, eliminate packing distortion, provide reliable accommodation for expansion in lines carrying high or low pressure steam, water, oil or other liquids. Better than bends. Simplify layouts. Write.



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Made of Copper-Bearing Steel
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Complete piping service
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POWER PIPING CO., Pittsburgh, Pa.

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Standard of the World
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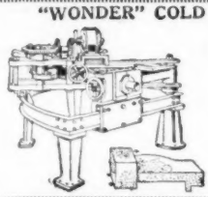
14 Sizes of Machines
What it costs to bend pipe our way. Per Bend:
1-in. pipe, 5 cents 4-in. pipe, 25 cents
2-in. pipe, 10 cents 6-in. pipe, 60 cents
8-in. pipe, $1.00.



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One Year to Pay

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PIPE CUTTING and THREADING MACHINES
where it is essential to have
Economy-Speed-Reliability
HAND—BELT—ELECTRIC
Ranges ¼-2 in. up to 8-16 in.
THE CURTIS AND CURTIS CO.
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One-Fifth The Weight of Cast Iron Pipe

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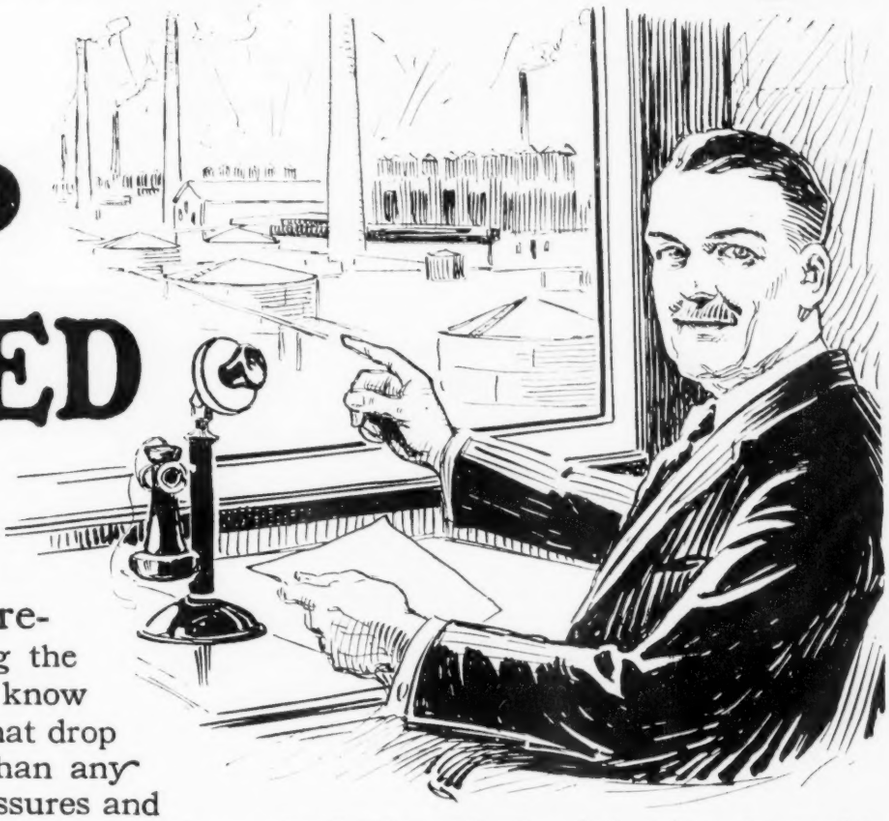
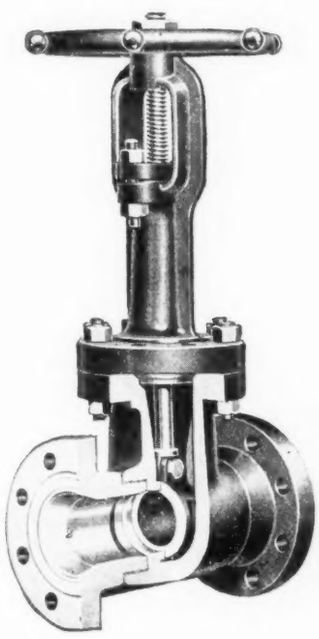
AN ABSOLUTELY TIGHT DURABLE PIPE
Fully 50% stronger than Straight Riveted Pipe of equal thickness. Light weight and simplicity of bolted connections results in low handling and installation expense. Extensively used in Power Plants for Atmospheric Exhaust, Cooling Pond and Forced Draft. Particularly adaptable for Suction and Discharge Water Lines, Vacuum Lines, Exhaust Steam Lines to Dryers, etc., and Large Low Pressure Air Lines.
ABENDROTH & ROOT MFG. CO.
Pipe Specialties Continuously Since 1867 Sales Office: Woolworth Bldg., N. Y.

The Best Valves & Fittings *Are* DROP FORGED



THIS statement must interest you as the man responsible for specifying the valves and fittings. We know from long experience that drop forged steel is better than any other metal for high pressures and temperatures. Many of the large power plants, oil refineries and other industries where safety, strength and accuracy are vital, have adopted VOGT as standard. There is a drop forged steel valve and fitting for every need and a large stock is always carried on hand in every size for immediate shipment. We have prepared a complete illustrated catalog showing the entire line of Vogt Drop Forged Steel Valves and Fittings which will be sent upon request.

Ask for Catalog F-6

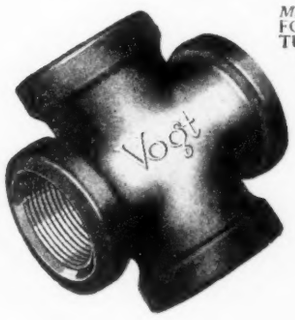


Vogt *Drop Forged Steel* VALVES & FITTINGS

HENRY VOGT MACHINE CO.
INCORPORATED
LOUISVILLE, KY.

New York Chicago Philadelphia Cleveland Dallas

Manufacturers of OIL REFINERY EQUIPMENT, DROP FORGED STEEL VALVES AND FITTINGS, WATER TUBE AND HORIZONTAL RETURN TUBULAR BOILERS, ICE MAKING AND REFRIGERATING MACHINERY.



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They operate with compressed air, entrain atmospheric air, discharge mixture at intermediate pressure and reduce consumption of compressed air 50%.

For further information address Jet Dept.

Schutte & Koerting Co., 1150 Thompson St., Philadelphia, Pa.

See our Valve Ad. on page 60

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FLOW INDICATORS
Give Satisfactory Service

These Orifice Indicators register continuously (in gallons per minute or pounds per hour) on a directly calibrated, large and easily read scale, the accurate measurement of the flow of liquids, steam or air.

TYPE "A" PRICE LIST
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3-4 inch $20.00 — 1¼ inch $22.00
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O-Z Hand Tachometer
Speeds at a glance. No timing
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Draws graphic charts of speeds.
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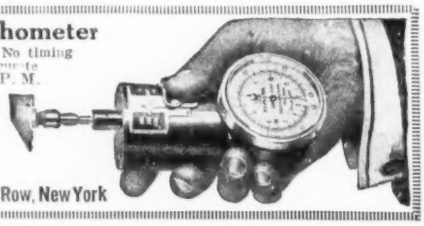

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Industry favors *Tycos* indicating, recording and controlling instruments because they embrace every type and size needed to meet the exacting requirements of power plants.

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(formerly "Columbia") has many valuable exclusive features, such as Time Punch; non-removable chart button; interchangeable recording system; instructions on chart plate, etc. *Write for Catalog H-32.*

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"Jagabi" Type C
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accurately indicate speeds and show speed variations. Large dial easily read. Built with one range (as shown) also with three and four ranges up to 24,000 r.p.m.

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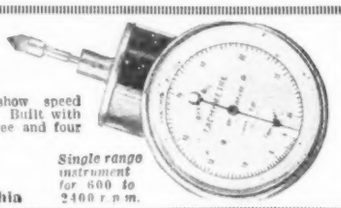

Single range instrument for 600 to 2400 r.p.m.

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for pressure, vacuum, draft, temperature, electrical units, liquid level, speed, and other factors. **Write for Bulletin 1007-G.**

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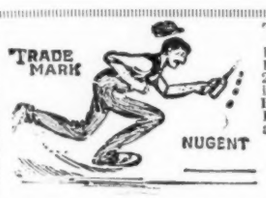

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DO THE HARD JOB EASILY.

No matter where the job may be or whether it is ⅛ in. to 12 in., a "TOLEDO" will cut and thread the pipe easily and quickly.

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THE MARK THAT WILL GUIDE YOU TO PERFECT PIPE THREADING.

A DART Union Free

Bronze to Bronze

A chance to see—in your own plant—what perfect union service means.

The picture shows you what Dart union construction looks like—the sample Dart will show you what the Dart can do for you—on the line.

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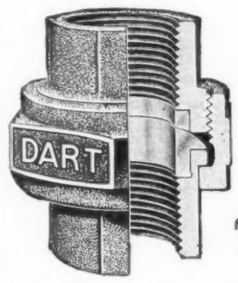

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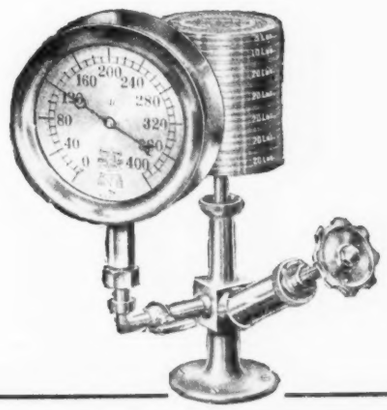
If not—it's not safe to use them, before they are readjusted.



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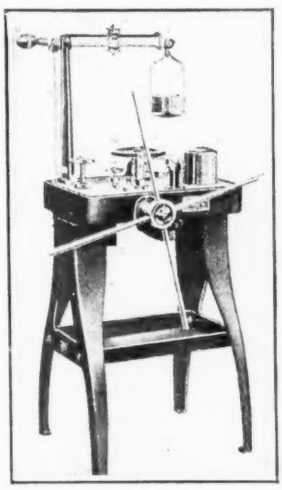
Pressure Gage Tester

will enable you to test and calibrate every pressure gage in your plant without elaborate preparation. The gage is simply attached to a standard connection and its readings are compared with test pressures obtained by means of standard weights bearing down on a plunger. Dependable up to 1000 lb. pressure.



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Accurate for all pressures to 25,000 lb. Compensated for all errors due to friction, temperature and barometric conditions, making correction factors unnecessary. Can be used for calibrating gages or for determining safe or bursting pressure of a pipe or a hollow vessel under test.

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Industrial Lubricants of Superior Merit

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Ask about our Spare Time Agency Proposition. It won't interfere with your regular work.

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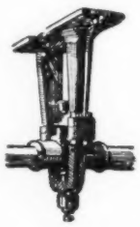

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For general lubricating purposes you can be sure of the best results, by using

MEXICAN GRAPHITE CUP GREASE

A combination of natural amorphous (not flake) graphite and a high quality grease derived from the best mineral oil. Made in four consistencies.

EXTRA SOFT—for high speed bearings, transmissions and sliding gears.

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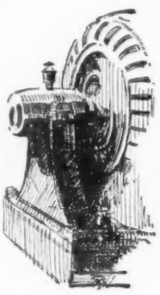

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Just as any mechanical device, The Cooke Seal Ring requires only lubrication. Gas or liquid, pressure or vacuum, high speed or low speed, heat or cold—none of these will affect the efficiency of The Cooke Seal Ring.

It rotates with the shaft.

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Metallic Packings of the Better Class
Ideal for superheated or saturated steam, ammonia, air or gas for all pressures and operating conditions. Last 5 to 25 years. Sold on approval.
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REFRIGERATING MACHINERY

"POSITIONS VACANT"

Good jobs appear under this heading in the

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MEN! *Consult* these columns for good jobs.

8 cents a word. ***Minimum $2.00 an insertion.***
0130

THE discovery of a new oil pool in the Texas Panhandle recently made it necessary for the Prairie Pipe Line Company to construct 300 miles of pipe line and seven Diesel-engined pumping stations to get the oil to market.

A De Laval Oil Purifier has been ordered for each of these new pumping stations!

This brings the total number of De Lavals operated by the Prairie Company to 60 or more.

Since this company is probably one of the world's largest users of Diesel engines, its consistent re-ordering of De Laval Purifiers over a period of several years certainly reflects the belief that these machines assure the most efficient lubrication obtainable. And every experienced operator knows that plant economy is largely a matter of lubrication.

Better write for further details today, being sure to ask for Bulletin 106-P.

The De Laval Separator Company
165 Broadway, New York
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DE LAVAL PACIFIC COMPANY
San Francisco

Operators of every type of Diesel engine have found that with the cleaner oil produced by the De Laval, bearing wear is materially reduced, sludge no longer accumulates in the oil grooves and channels of the engine, the necessity for disassembling the unit for manual cleaning of the oiling system is practically eliminated, and the same oil can be kept in service indefinitely.

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Centrifugal purification of fuel oil is equally important. Clean fuel oil minimizes wear on cylinder liners, injection feed nozzles and fuel pumps, and removes the trouble attending the burning of oil containing water. The De Laval Fuel Oil Purifier is built especially for this service, being of vapor-tight construction to permit the purification of oil at high temperatures. Its work is fully described in Bulletin 106-P.

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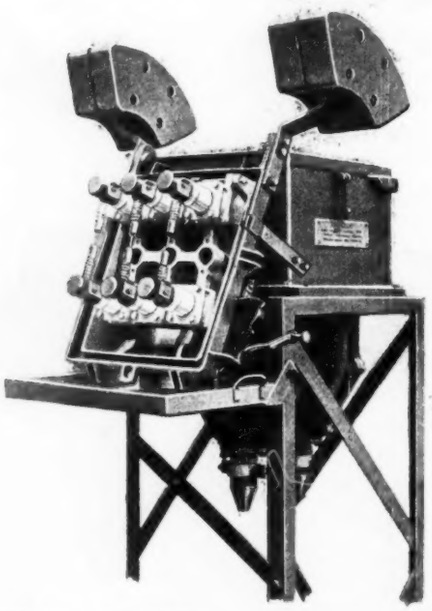
SWITCH-FUSES



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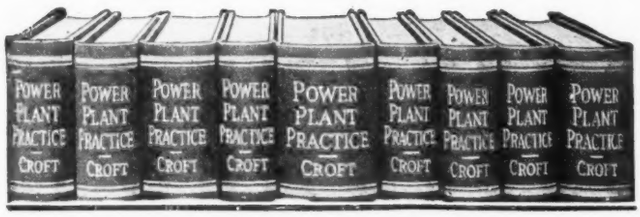

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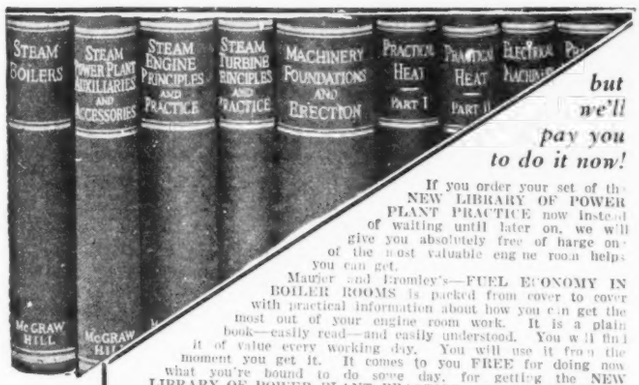
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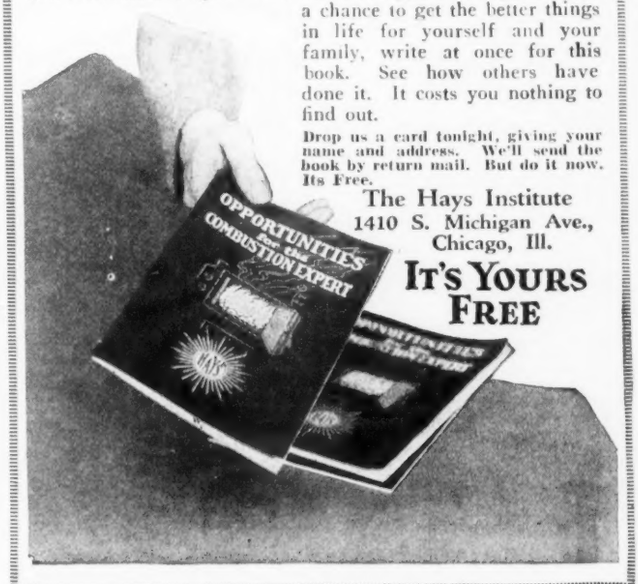

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OPERATING engineer, all round experience. Record in economy. Go anywhere. Prefer place with living quarters for two. PW-234, Power, 7 So. Dearborn St., Chicago, Ill.

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POSITION wanted as mechanical superintendent, master mechanic or chief engineer. College grade education. Massachusetts license, 8 years erecting engines, turbines, condensers. 20 years' experience power plants. PW-238, Power, Tenth Ave. at 36th St., New York.

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PACIFIC coast representative available. Experienced salesman on steam, mill and contractors supplies and equipment is returning to San Francisco after two years absence. Office executive and purchasing experience as well as sales East and West. SA-240, Power, Tenth Avenue at 36th St., New York.

SALES engineer with 15 years' established record covering Western states with mill, mine, power plant lines, can handle one or two additional lines of merit. SA-241, Power, 7 South Dearborn St., Chicago, Ill.

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1—Bullock 260 Kva A.C. Generator, with 17½ x 24 Buckeye high speed engine.
1—General Electric 100 Kw D.C. Generator with Steam Turbine and Reduction Gear.
1—Sprague 40 Kw. D.C. Generator, belt-drive.
1—General Electric 75 Kw. D.C. Generator, with 115 Hp. motor.
4—Burke 35 Kw D.C. Generators, with 50 Hp. motors.
1—General Electric Type MP. Class 4-9-1150, form H, 125 volt, 72 amp., 1150 r.p.m., direct current generator, with Wheland 8-in. x 10-in. steam engine.

Switchboards, Instruments, etc.

Nashville Industrial Corporation
Old Hickory, Tennessee.

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COMPLETE POWER PLANT

Consisting of

3—300 HP. Wickes Vertical Water Tube Boilers.
2—250 HP. Ball Erie J-10 R. H. Side Crank Corliss Valve Engine 17x24.
1—Westinghouse Vertical Compound Engine, 8x13 x8, direct connected to
1—Westinghouse 40 Kw., 2200 v., 3 ph., 60 cycl., 400 r.p.m., A.C. Generator.
2—American Steam Pump Co. Boiler Feed Pumps, 10x7½x12, Feed Water Heaters.
Coal Handling Equipment, Overhead, Coal Bins.
3—Akerlund & Semmes, No. 10 Type F. Gas Producers, 10-ft. Inside Dia. x 12-ft.1½-in. High, No. 6, B. E. Blower, Complete.

Visit this plant at Gauley Mills, W. Va. All equipment in excellent condition.
Send for complete list.

CONSOLIDATED PRODUCTS CO.
GAULEY MILLS, W. VA.

FOR SALE

GAS ENGINE

100-hp. Miller Engine—Horizontal Two Cylinder. Have Changed to Electric Drive—need space—will sell cheap if moved quick.

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A splendid opportunity for someone to sell a product of merit. Write at once.

BO 227, Power,
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3—Pressure Water Filters, steel tanks 4-ft. 6-in. dia. x 8-ft. long, ⅜-in. plate, longitudinal seams, double lap riveted, both heads domed.

NASHVILLE INDUSTRIAL CORPORATION
Old Hickory, Tennessee.

MOTORS

Three Phase, 60 Cycle

Qu.	Make	H.P.	Type	Volt	Speed
1	G. E.	7½	KT	440	1200
2*	G. E.	7½	I-8 Form M	440	900
25	A. C.	7½	13D-117-613-IV	440	1200
1*	G. E.	15	I-10 Form M	440	720
1*	G. E.	15	I Form M	220	900
15	West.	30	CS	440	1200
1	A. C.	15	17K18	440	800
3	G. E.	30	KT332 Form B	440	1200
2*x	West.	40	CW	440	1200
1*x	G. E.	40	MT 356Y	440	1200
15*x	G. E.	40	MT 336Y	440	1200
1	West.	75	CS	440	1800
6	G. E.	75	I	440	720
1	West.	150	CS I 792 74B	2200	1800
1	G. E.	300	I Form K	2200	1200

Above motors squirrel cage with exception of those marked *, which are slip ring. Motors marked *x are vertical.

Starting compensator having no voltage release and overload relays furnished with motors 7½ H.P. and above. Controls and resistance furnished with slip ring motors. Automatic remote control with 40 and 50 H.P. slip ring motors.

Nashville Industrial Corporation
Old Hickory, Tennessee

STEAM PUMPS

FOR SALE

Qu	Type	Make	Size
1	Duplex	Advance	4 1/2x2 3/4x4
1	Simplex	American	6x6x12
1	Simplex	Dean Bros.	3 1/2x3 1/4x4
1	Simplex	Dean Bros.	4x2 1/4x5
1	Simplex	.....	4 1/2x2 3/4x7
1	Simplex	Dean Bros.	5 1/2x3x7
2	Simplex	Dean Bros.	5 1/2x5x7
1	Duplex	Dean Bros.	7x4x10
1	Simplex	Dean Bros.	10x7x12
1	Simplex	Dean Bros.	10x8x12
1	Simplex	Dean Bros.	10 1/4x7x12
2	Duplex	Dean Holyoke	3x2x3
1	Simplex	Dean Holyoke	8x8x10
1	Duplex	McGowan	4-1/8x2 1/4x5
1	Duplex	McGowan	4 3/4x2 3/4x4 1/2
1	Duplex	McGowan	12x10x12
1	Simplex	Reilly	4x2 1/4x7
1	Simplex	Reilly	5x2 1/4x7
1	Simplex	Reilly	6x4x7
1	Simplex	Reilly	7x4x10
1	Simplex	Reilly	7x5x10
1	Simplex	Reilly	8x5x10
1	Duplex	Scranton	4 1/2x2 3/4x4
1	Duplex	Smith-Vaile	20x10x18
1	Simplex	Union Burnham	4x2 1/2x5
2	Simplex	Union Burnham	5x5x10
1	Simplex	Union Burnham	5x7x10
1	Simplex	Union Burnham	8 1/2x7x10
1	Duplex	Worthington	5 1/4x4 3/4x5
31	Duplex	Worthington	6x2 1/2x6
9	Comp. Duplex	Worthington	12&18x12x12
1	Simplex	Blake	6x8x8
1	Simplex	Blake	10x10x12
1	Simplex	Blake	10x12x10
1	Simplex	Cameron	8x8x6
1	Simplex	Knowles	10x10x12

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1—75 kw. G.E. Synchronous Motor, 3 ph., 25 cy., 550 v., 715 r.p.m., direct connected to a 50 kw. G.E. type RC generator, 250 v. D.C., 715 r.p.m. Exciter is direct connected.....**$1100.00**

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1—75 kw. Synchronous M-G Set *consisting of*
1—Western Electric Synchronous Motor, 3 ph., 60 cy., 220/440 v., 900 r.p.m., direct connected to 75 kw. rebuilt Allis-Chalmers Generator, 250 v. D.C., 900 r.p.m. Exciter is direct connected. **$1150.00**

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2—625-Kva. (1 new, 1 used 4 days)
750 and 937 Kva. Mixed Press Turbos
Bridge Cranes 25 to 100 ft. Span

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2—New 1001 HP., 200 lb.

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Used and Rebuilt Engine Generator Sets, Turbo Generator Sets, Motors, Rotary Converters, Generators, Motor Generator Sets, Engines, Boilers, Steam and Electric Machinery of all kinds also Machine Tools. Send for our new machinery list. Yours for the asking.

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19—No. 33. Size 3/4-in., and one trap size 1-in. All in first class condition. Practically new.

THE LIPPINCOTT COMPANY
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Complete plant ready for installation, including
2—400-hp. **Wickes Boilers,** with all equipment.
Large list of heating and power boilers in stock. *Write for prices.*

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1—Self-supporting, 11-ft. dia. x 200-ft. high.
1—Self-supporting, 8-ft. dia. x 150-ft., 3/4-in. plate.
10—Self-supporting, 70-ft. high, 4-ft. dia. at base, 2-ft.6-in. at top, 3/4-in. plate.
1—Guyed, 30-in. dia. x 32-ft. high, with 4-ft. base, 3/16-in. plate.

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Old Hickory, Tennessee.

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125 hp. Locomotive Portable Boiler, 125 lb. steam working pressure, A.S.M.E. code construction.

Engine Generator

125 kw., 240 volt, 3 phase, 60 cycle, General Electric, A.C., Generator, direct connected to Harrisburg Horizontal Automatic Engine.

THE O'BRIEN MACHINERY CO.
113 NORTH THIRD ST.
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5—823 hp. Babcock & Wilcox Stirling Water Tube, Class M-30, 200 lbs. pressure. Westinghouse stokers and all accessories.
6—400 hp. Wickes Vertical Water Tube, 160 lbs.
3—350 hp. Rust, type C 5-14.
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Also pumps, compressors, accessories, etc.

Nashville Industrial Corporation
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250 kva., 220-440-2200 volts G. E. 3 ph., 60 cy. and Chuse Uniflow Engine.
150 kw., 125-250 volts, 3 wire G. E. Type LDS and Erie City Corliss Valve Engine.

Other Units, All Sizes.

H. R. WILSON MACHY. CO., St. Louis, Mo.
Boilers—Cranes—Motors—Compressors

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2—250-ton De La Vergne Ammonia Compressors, 18-in. dia. x 24-in. stroke, d.c. to Ames 370 hp. Uniflow engines, 23-in. dia. x 24-in. stroke.
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9—Worthington 12x18x12x12 Tandem Compound duplex brine pumps. Used only a short time. Good condition.

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is frequently the difference between having good needed equipment or doing without it.

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1—Olney Warren 8 in. x 10 in., vertical, 25 hp., 24 in x 8 in. flywheel.
2—25 hp. 6 in. x 8 in. Vertical Twin Cylinder, with 30 in. x 12 in. flywheel, throttle valve and 2 in. governor.
1—60 hp. Atlas 14 in. x 20 in., horizontal, automatic, side crank, left hand type, throttle valve and 3 1/2 in. governor; pulley 72 in. x 20 in.
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Nashville Industrial Corporation
Old Hickory, Tennessee

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Power Plant Equipment
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TURBO GENERATORS

50 kw. 250 v., Crocker-Wheeler-Terry.
50 kw., 125 v., D.C. Westghse.
150 kw., 3 ph., 60 cy., Westgh.
200 kw., Unused 3 ph., 60 cy., Allis-Chalmers to Moore turbine.
300 kw., 3 ph., 60 cy., G.E.
300 kw., 3 ph., 60 cy., Westgh.
300 kw., 600 v., D.C. Westghse
300 kw., 250 v., D.C. Westghs.
500 kw., 3 ph., 60 cy., Allis-Chalmers.
600 kw., 3 ph., 60 cy., NEW G.E.
1000 kw., 2 ph., 60 cy., G.E.
1000 kw., 3 ph., 60 cy., G.E.
6000 kw., 3 ph., 60 cy., G.E.
720 hp., G.E. turbine to 10,000 cu.ft. compressor.

ENGINE UNITS (125 Volts)

30 kw., G.E. Marine unit.
35 kw., G.E. to Ames uniflow.
50 kw., Westghse. to Ames center crank.
125 kw., G.E. to Ames uniflow.
150 kw., G.E. to Chuse side crank.

Always a Large Stock of
Transformers
Turbines
Engine Driven Units
Motor Generators
Motors
Dynamos
of every description Ready for Immediate Delivery

ENGINE UNITS (250 Volts)

50 kw., Crocker-Wheeler to Ames.
50 kw., Gen. Elec., 3 wire, to Erie Ball.
75 kw., Crocker-Wheeler, 3 wire to Harrisburg.
75 kw., Westghse. to Erie Ball.
100 kw., Gen. Elec. to Skinner.
125 kw., Gen. Elec., 3 wire, to Erie Ball.
275 kw., Gen. Elec., 3 wire, to Wetherill.
325 kw., Westghse., 3 wire, to Rice-Sargent.

A.C. ENGINE UNITS

30 kw., 3 ph., 60 cy., G.E., belted.
50 kva., Crocker-Wheeler, 3 ph., 60 cy., to Ames.
62½ kva., G.E., 3 ph., 60 cy., belted.
90 kva., G.E., 3 ph., 60 cy., belted.
100 kw., G.E., 3 ph., 60 cy., belted.
125 kva., 3 ph., 60 cy., Allis to Harrisburg.
145 kva., 3 ph., 60 cy., Westgh. for connection to engine.
150 kw., G.E., 2 ph., 60 cy., to Ames.
300 kw., 3 ph., 60 cy., G.E. to Harrisburg 4 valve.
200 kw., 3 ph., 60 cy., Westghse. belted.
300 kw., 3 ph., 60 cy., G.E., belted.
500 kw., 3 ph., 60 cy., G.E. to Ridgway, 4 valve.
635 kw., 3 ph., 60 cy., G.E. to Rice-Sargent.

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Special Selection Generating Equipment At Bargain Prices

These units have been completely overhauled and are in condition for all practical purposes equal to new.

All machines owned by this company. We invite inspection.

185 kw., 2300 volt, 3 phase, 60 cycle, 225 r.p.m., Western Electric, A.C. Generator direct driven by a 227 hp. Skinner slide valve Engine.
72 kw. 2300 volt, 3 phase, 60 cycle, 257 r.p.m., Western Electric, type TRE, form D, A.C. Generator direct driven by a 125 hp., 14x15 left hand Skinner slide valve Engine.
100 kw., 125/250 volt, 3 wire, D.C. 260 r.p.m., Westinghouse compound wound Generator direct driven by a Harisburg Fleming 12x19½x14 Tandem Compound Engine.
35 kw., 230/250 volt, D.C., 300 r.p.m., Western Electric, type L3E Generator direct driven by a Skinner slide valve Engine.
25 kw., 220 volt, D.C., 350 r.p.m., Sturtevant Generator direct driven by a 9x8 Sturtevant vertical Engine.
12½ kw., 220 volt, D.C., 375 r.p.m. Engberg Generator direct connected to a 6x6 Engberg vertical Engine.

Special Bargain

100 G.P.M., 110-lb. pressure, 4-stage Hill Centrifugul Pump with direct connected 230-volt D. C. General Electric motor and Cutler Hammer Fire Control Panel.

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A Fractional H.P. Motor or a Complete Power Plant

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1—Worthington Laidlaw 15 and 26x20x24-in. 2,570 cu. ft. per min. at 150 r.p.m.
1—Gardner 12x16x12.
1—Chicago Pneumatic Portable 12x7¾x12, on trucks with 27 hp. gasoline engine.
1—Westinghouse Air Brake type, size 9½x5x10 with air receiver tank.
3—Ingersoll-Rand Class ER1, 120 cu. ft. per min. at 350 r.p.m.
1—No. 0 Auto Air Compressor 3x4-in., with air receiver tank.

All in Good Condition.

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Old Hickory, Tennessee

MOTORS Rebuilt Guaranteed

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1—125-hp. Westing., Type SK, 600 r.p.m.
1—75/100-hp. West., SK-210, 200/600 r.p.m.
1—75 hp. Westing., SK, 825/1125 r.p.m.
1—65-hp. Westing., SK, 575 r.p.m.
1—50-hp. Westing., SK, 975 r.p.m.
2—40-hp. G. E., RC, 600 r.p.m.
1—35/50-hp. G. E., RLC, 400/1200 r.p.m.
1—20/25-hp. G. E. RLC, 400/1200 r.p.m.
6—11½-hp. West., SK, 500/1500.

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1—625 kva., 480 v., 3 ph., 60 cy. Allis-Chalmers.
1—187 kva., 40 v. high pressure non-condensing Westinghouse turbine, complete with auxiliaries.

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SLIP RING MOTORS

Hp.	*Make*	*Ph.*	*Cy.*	*Volts*	*Rpm.*
300	Allis-Chal.	3	60	220-440	870
280	Fair.-Morse	3	60	220-440	600
175	Allis-Chal.	3	60	550	600
100	Westg. (C.W.)	3	60	550	600
100	Westg. (C.W.)	2	60	220	600
100	Westg. (C.W.)	3	60	220-440	600

Other slip-ring motors down to ½ hp.

SQUIRREL CAGE MOTORS

150	G. E.	3	25	440	375
150	G. E. (K.T.)	3	60	2200	870
100	Cr.-Wh.	3	60	220-440	1750
75	Cr.-Wh.	3	60	220-440	1160
50	Gen. Elec	3	60	2 0-440	900

Other squirrel cage motors down to ¼ hp.

DIRECT CURRENT MOTORS
All 220 volts-230 volts

Hp.	*Make*	*Speed*
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100	Sprague (C)	550/1100
60	Westg. (S)	920
60	Electro Dynamic	525/1050
50	Westg. (S)	750/955

Other D.C. motors down to ¼ hp.

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Said the man whose elevator we had changed over to the Ridgway Steam-Hydraulic.

The machines were working noiselessly and speedily and stuff was getting through the factory as never before in its history.

AND THE ELEVATORS WERE NOT COSTING ONE CENT FOR POWER.

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Dangerous counterweights
Fires
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Interrupted service
Big electric power bills
Overloading and breakdowns

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and get Perfection in Elevator Service.

No drummer or agent calls to see you. If you don't "Get It On Your Own," you are not likely to

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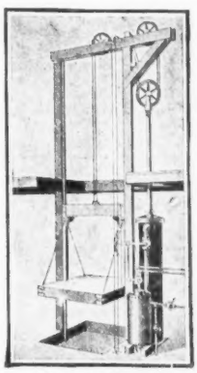

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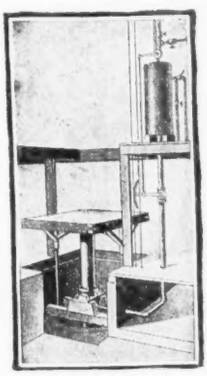
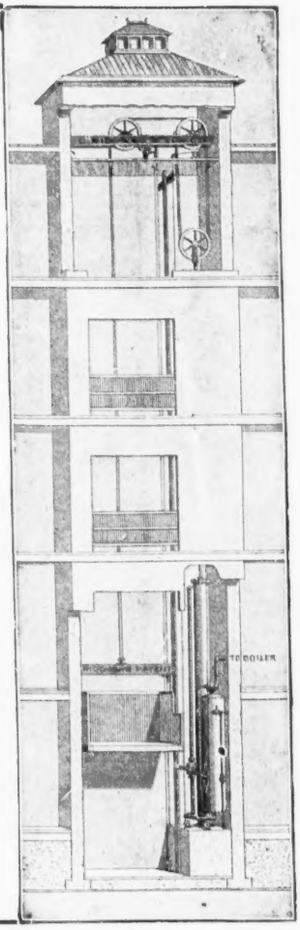


Direct Acting



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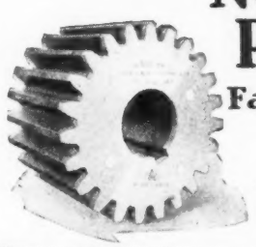

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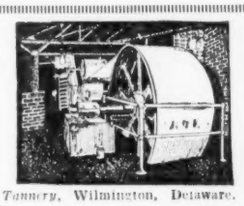

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WHAT AND WHERE TO BUY

Equipment, Apparatus and Supplies Used in the Power Plant Field with Names and Addresses of Manufacturers and Distributors Whose Advertisements Appear in This Issue

See Last Page for Alphabetical Index

Accumulators, Steam
Ruths Accumulator Co., N. Y.
Aftercoolers and Receivers, Air
Alberger Heater Co., Buffalo
Chicago Pneu. Tool Co., N. Y.
Ingersoll-Rand Co., N. Y.
Nordberg Mfg. Co., Milwaukee

Air Chambers
Hercules Float Wks., Springfield, Mass.

Air Washers
Spray Engineering Co., Boston

Alternators, Turbo
Elliott Co., Wellsville, N. Y.
General Electric Co., Schenectady
Ridgway (Pa.) Dynamo & Engine Co.
Terry Steam Turbine Co., Hartford

Annunciators, Audi-Visible
Cory & Son, Chas., N. Y.

Arches, Boiler Door
McLeod & Henry Co., Troy, N. Y.

Arches, Flat, Suspended
Bigelow Arch Co., Detroit
Beiler Tube Co. of Amer., Pittsburgh
Brady Conveyors Corp., Chicago
Burke Engineering Co., Holland, Mich.
Detrick Co., M. H., Chicago
Hofft Co., M. A., Indianapolis
Illinois Stoker Co., Alton, Ill.
Liptak Fire Brick Arch Co., Mexico, Mo.
McLeod & Henry Co., Troy, N. Y.
Walsh Fire Clay Products Co., St. Louis

Ash Gates and Hoppers for Pulverized Fuel
Allen, Sherman, Hoff Co., Phila.
Jeffrey Mfg. Co., Columbus, O.

Ash Handling Equipment
Allen, Sherman, Hoff Co., Phila.
Beaumont Co., R. H., Phila.
Brady Conveyors Corp., Chicago
Chain-Belt Co., Milwaukee
Combustion Engrg. Corp., N. Y.
Detrick Co., M. H., Chicago
Gifford-Wood Co., Hudson, N. Y.
Hayward Co., N. Y.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Chicago
Robins Conveying Belt Co., N. Y.
United Conveyors Corp., Chicago
Webster Mfg. Co., Chicago

Ash Quenchers
Allen, Sherman, Hoff Co., Phila.

Ash Sluicing Systems
Allen, Sherman, Hoff Co., Phila.

Ash Tank, Steel
Heine Boiler Co., St. Louis

Ash Tanks, Tile
United Conveyors Corp., Chicago

Baffle Walls, Boiler
Boiler Engineering Co., Newark
Carborundum Co., Perth Amboy
Engineer Co., N. Y.
King Refractories Co., Buffalo
Liptak Fire Brick Arch Co., Mexico, Mo.
McLeod & Henry Co., Troy, N. Y.
Walsh Fire Clay Products Co., St. Louis

Baffles, Monolithic
Boiler Engineering Co., Newark
King Refractories Co., Buffalo

Bearings
Hoyt Metal Co., St. Louis

Bearings, Roller
Timken Roller Bearing Co., Canton, Ohio

Bearings, Thrust
Timken Roller Bearing Co., Canton, Ohio

Belting
Greene, Tweed & Co., N. Y.
N. Y. Belting & Packing Co., N. Y.
Quaker City Rubber Co., Wissinoming, Phila.
Rhoads & Sons, J. E., Phila.

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Jeffrey Mfg. Co., Columbus, O.
Keasbey & Mattison Co., Ambler, Pa.
N. Y. Belting & Packing Co., N. Y.

Belting, Leather, Waterproof
Rhoads & Sons, J. E., Phila.

Belting, Rubber
N. Y. Belting & Packing Co., N. Y.
Quaker City Rubber Co., Wissinoming, Phila.
U. S. Rubber Co., N. Y.

Bins
Blaw-Knox Co., Pittsburgh
Brown Hoisting Machinery Co., Cleveland

Blowers, Centrifugal
De Laval Steam Turbine Co., Trenton
Elliott Co., Wellsville, N. Y.
General Electric Co., Schenectady
Green Fuel Economizer Co., Beacon, N. Y.
Jeffrey Mfg. Co., Columbus, O.
Sturtevant Co., B. F., Hyde Park
Wing Mfg. Co., L. J., N. Y.

Blowers, Fan
Buffalo Forge Co., Buffalo
Clarage Fan Co., Kalamazoo, Mich.
Engineer Co., N. Y.
General Electric Co., Schenectady
Green Fuel Economizer Co., Beacon, N. Y.
Jeffrey Mfg. Co., Columbus, O.
Sturtevant Co., B. F., Hyde Park
Wing Mfg. Co., L. J., N. Y.

Blowers, Forced Draft
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Clarage Fan Co., Kalamazoo, Mich.
Jeffrey Mfg. Co., Columbus, O.
McClave-Brooks Co., Scranton, Pa.
Sturtevant Co., B. F., Hyde Park
Wing Mfg. Co., L. J., N. Y.

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Clarage Fan Co., Kalamazoo, Mich
Jeffrey Mfg. Co., Columbus, O.
Sturtevant Co., B. F., Hyde Park

Blowers, Soot for Boiler Tubes
Huyette Co., Paul B., Philadelphia
Vulcan Soot Cleaner Co., Webster Bldg., Du Bois, Pa.

Blowers, Steam Jet
Chesterton Co., A. W., Boston
McClave-Brooks Co., Scranton, Pa.
Schutte-Koerting Co., Phila.

Blowers, Turbine
Coppus Engineering Corp., Worcester, Mass.
Elliott Co., Wellsville, N. Y.
Ingersoll-Rand Co., N. Y.
Moore Steam Turbine Corp., Wellsville, N. Y.
Sturtevant Co., B. F., Hyde Park
Terry Steam Turbine Co., Hartford
Wing Mfg. Co., L. J., N. Y.

Boiler, Cleaning Process
North American Fibre Products Co., Cleveland

Boiler Compound
Garratt-Callahan Co., Chicago
Paige & Jones Chemical Co., Hammond, Ind.

Boiler Door Latches
De Waters Safety Latch Co., N. Y.

Boiler Fronts
Erie City Iron Wks., Erie, Pa.
McClave-Brooks Co., Scranton, Pa.

Boiler Insulation
Keasbey & Mattison Co., Ambler, Pa.

Boiler Setting
American Chimney Corp., N. Y.
Ashland (Ky.) Fire Brick Co.
Ballard, Sprague & Co., N. Y.
Botfield Refractories Co., Phila.
Carborundum Co., Perth Amboy
Cement-Gun Co., Allentown, Pa.
CoKal Stoker Corp., Chicago
Custodis Chimney Constr. Co., Alphons, New York
Detrick Co., M. H., Chicago
Erie City Iron Wks., Erie, Pa.
Furnace Engineering Co., N. Y.
Green Fire Brick Co., A. P., St. Louis
Illinois Stoker Co., Alton, Ill.
Keystone Refractories Co., N. Y.
Laclede-Christy, St. Louis
Liptak Fire Brick Arch Co., Mexico, Mo.
Naismith & Sons, Geo., Pittsburgh
Obermayer Co., S., Chicago
Plibrico Jointless Fire Brick Co., Chicago
Queen's Run Refractories Co., Lock Haven, Pa.
Rust Engineering Co., Pittsburgh
Walsh Fire Clay Products Co., St Louis

Boiler Tube Cleaners
(See Blowers, Soot, for Boiler Tubes)
(See Scale Removers)
(See Tube Cleaners Boiler)

Boilers, Cross-Drum
Babcock & Wilcox Co., N. Y.
Edge Moor (Del.) Iron Co.
Heine Boiler Co., St. Louis
Kingsford Fdry. & Mach. Co., Oswego, N. Y.
Springfield (Ill.) Boiler Co.
Walsh & Weidner Boiler Co., Chattanooga
Wickes Boiler Co., Saginaw, Mich.

Boilers, Heating
Erie City Iron Wks., Erie, Pa.

Boilers, Locomotive
Connelly Boiler Co., D., Cleveland

Boilers, Portable
Erie City Iron Works, Erie, Pa.

Boilers, Return Tubular
Bigelow Co., New Haven, Conn.
CoKal Stoker Corp., Chicago
Connelly Boiler Co., D., Cleveland
Erie City Iron Wks., Erie, Pa.
Murray Iron Wks. Co., Burlington
Smith & Sons Co., S., Paterson, N. J.
Union Iron Works, Erie, Pa.
Vogt Mach. Co., Henry, Louisville
Walsh & Weidner Boiler Co., Chattanooga

Boilers, Vertical Water Tube
Babcock & Wilcox Co., N. Y.
Bigelow Co., New Haven, Conn.
Casey-Hedges Co., Chattanooga
Erie City Iron Works, Erie, Pa.
Wickes Boiler Co., Saginaw, Mich.

Boilers, Waste Heat
Edge Moor (Del.) Iron Co.
Wickes Boiler Co., Saginaw

Boilers, Water Tube
Babcock & Wilcox Co., N. Y.
Bigelow Co., New Haven, Conn.
Casey-Hedges Co., Chattanooga
Connelly Boiler Co., D., Cleveland
Edge Moor (Del.) Iron Co.
Erie City Iron Works, Erie, Pa.
Heine Boiler Co., St. Louis
Ladd Water Tube Boiler Co.
Murray Iron Wks. Co., Burlington
Springfield (Ill.) Boiler Co.
Union Iron Works, Erie, Pa.
Vogt Machine Co., Henry, Louisville
Walsh & Weidner Boiler Co., Chattanooga
Wickes Boiler Co., Saginaw, Mich.

Books
McGraw-Hill Book Co., N. Y.

Breechings
Littleford Bros., Cincinnati
Smith & Sons Co., S. Paterson, N. J.

Brick, Fire
Ashland (Ky.) Fire Brick Co.
Bartley Crucible Co., Jonathan, Trenton
Botfield Refractories Co., Phila.
Carborundum Co., Perth Amboy
General Refractories Co., Phila.
Laclede-Christy, St. Louis
McLeod & Henry Co., Troy, N. Y.
Obermayer Co., S., Chicago
Plibrico Jointless Fire Brick Co., Chicago
Queen's Run Refractories Co., Lock Haven, Pa.
Walsh Fire Clay Products Co., St. Louis

Brick, Insulation
Quigley Furnace Specialties Co., N. Y.

Bucket Carrier, Pivoted
Chain-Belt Co., Milwaukee
Gifford-Wood Co., Hudson, N. Y.
Link-Belt Co., Chicago

Buckets, Clam Shell
Blaw-Knox Co., Pittsburgh
Brown Hoisting Machinery Co., Cleveland
Hayward Co., N. Y.
Link-Belt Co., Chicago

Buckets, Electric Motor
Hayward Co., N. Y.

Buckets, Orange Peel
Hayward Co., N. Y.

Buildings Portable Steel
Blaw-Knox Co. Pittsburgh

Bunkers, Coal
Allen, Sherman, Hoff Co., Phila.
Beaumont Co., R. H., Phila.
Brown Hoisting Machinery Co., Cleveland
Gifford-Wood Co., Hudson, N. Y.
Link-Belt Co., Chicago

Burners, Gas
Gas Combustion Co., Pittsburgh
Mettler Co., Lee B., Los Angeles

Burners, Oil
Bethlehem (Pa.) Steel Corp
Combustion Engrg. Corp., N. Y.
Engineer Co., N. Y.
Morse Dry Dock & Repair Co., Brooklyn
National Airoil Burner Co., Phila.
Peabody Engr. Corp., N. Y.
Schutte-Koerting Co., Phila.

Burners, Powdered Coal
Illinois Stoker Co., Alton

Bushings
Gifford-Wood Co., Hudson, N. Y.

Car Pullers, Electric, Capstan & Hand
Gifford-Wood Co., Hudson, N. Y.
Webster Mfg. Co., Chicago

Castings, Brass and Iron
Neemes Fdry., Inc., Troy

Castings, Grey Iron
Erie City Iron Works, Erie, Pa.
Fuller-Lehigh Co., Fullerton, Pa.
Gifford-Wood Co., Hudson, N. Y.
Harrisburg (Pa.) Fdy. & Mach. Wks.
Riley Stoker Corp., Worcester

Cement, Fire Brick
Ashland (Ky.) Fire Brick Co.
Botfield Refractories Co., Phila.
General Refractories Co., Phila.
Keystone Refractories Co., N. Y.
King Refractories Co., Buffalo
McLeod & Henry Co., Troy, N. Y.
Obermayer Co., S., Chicago
Plibrico Jointless Fire Brick Co., Chicago
Walsh Fire Clay Products Co., St. Louis

Cement Guns
Cement-Gun Co., Allentown, Pa.

Cement, High Temperature
Botfield Refractories Co., Philadelphia

Cement, Iron
Obermayer Co., S., Chicago
Smooth-On Mfg. Co., Jersey City

Cement, Pipe Joint
Smooth-On Mfg. Co., Jersey City, N. J.

Chain Drive
Chain-Belt Co., Milwaukee
Jeffrey Mfg. Co., Columbus, O.
Morse Chain Co., Ithaca, N. Y.
Philadelphia (Pa.) Gear Works

Chimneys (See Stacks)

Clamps, Pipe
Yarnall-Waring Co., Mermaid Ave., Phila.

Clay, Fire
Ashland (Ky.) Fire Brick Co.

Clutches, Friction
Gifford-Wood Co., Hudson, N. Y.
Jones Fdry. & Mach. Co., W. A., Chicago
Link-Belt Co., Chicago
Webster Mfg. Co., Chicago

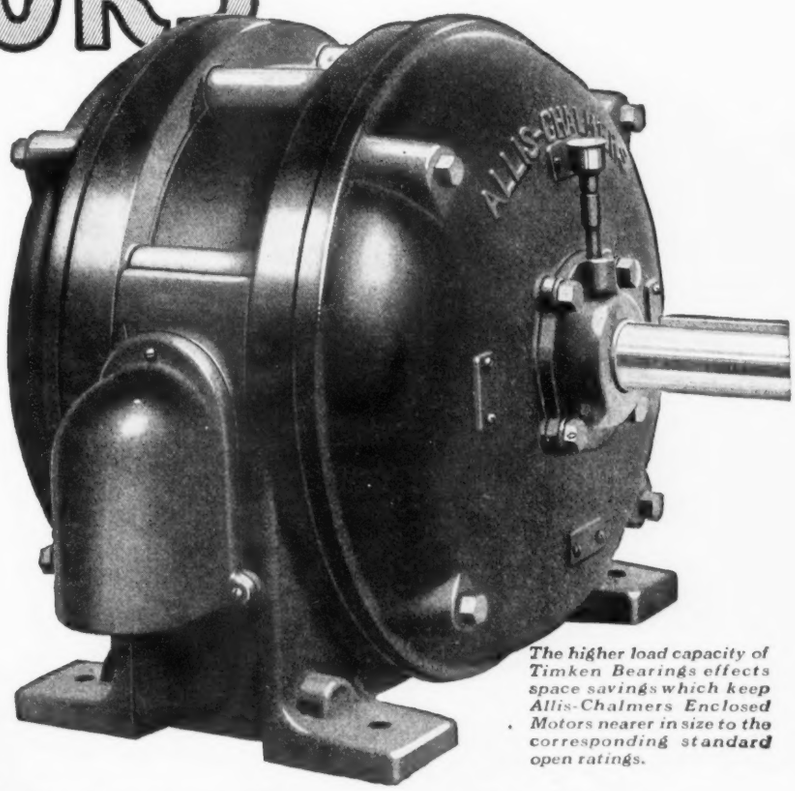
Coal
Peale, Peacock & Kerr, N. Y.
Pittsburgh (Pa.) Coal Co.

Coal Bunker Lining
Wailes Dove-Hermiston Corp., N. Y.

Coal Crushers
American Pulverizer Co., St. Louis
Beaumont Co., R. H., Phila.
Brown Hoisting Machinery Co., Cleveland
Erie City Iron Wks., Erie, Pa.
Furnace Engineering Co., N. Y.
Fuller-Lehigh Co., Fullerton, Pa.
Gifford-Wood Co., Hudson, N. Y.
Grindle Fuel Equip. Co., Harvey
Jeffrey Mfg. Co., Columbus, O.
Kennedy-Van Saun Mfg. & Eng. Corp., N. Y.
Link-Belt Co., Chicago
Webster Mfg. Co., Chicago

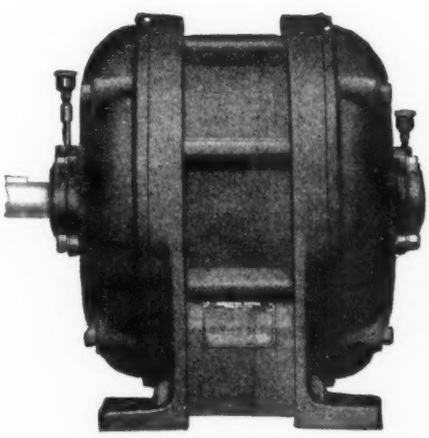
Coal Handling Equipment
Beaumont Co., R. H., Phila.
Brown Hoisting Machinery Co., Cleveland

ALLIS-CHALMERS MOTORS



The higher load capacity of Timken Bearings effects space savings which keep Allis-Chalmers Enclosed Motors nearer in size to the corresponding standard open ratings.

The liberal use of electric steel had made Allis-Chalmers motor frames virtually shock-proof .... the unit-assembly of laminations assured permanent core rigidity .... the silver brazing of rotor bars to end rings meant an indestructible rotor .... a special final insulation process kept the windings like new .... and then the moving parts were given equal permanence through the use of Timken Tapered Roller Bearings.



Shaft length averages 15% less in Allis-Chalmers Anti-Friction Types.

Timkens carry thrust as well as radial loads, with perfectly lubricated rolling motion, under all conditions. Bearing capacity is increased, but shaft length is reduced, permitting a whole series of improvements and economies—from basic design to operating position on your job.

Every motor user is interested when the Allis-Chalmers name is on motors that can be kept wear-proof with only a very few greasings yearly!

ALLIS-CHALMERS MFG. CO., Milwaukee
District Sales Offices in all Principal Cities

Chain-Belt Co., Milwaukee
Gifford-Wood Co., Hudson, N. Y.
Hayward Co., N. Y.
Hunt Co., C. W., West New Brighton, N. Y.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Chicago
Robins Conveying Belt Co., N. Y.
Sauerman Bros., Chicago
Webster Mfg. Co., Chicago

Cocks, Brass & Iron Body
Homestead (Pa.) Valve Mfg. Co.

Cocks, Gage
Huyette Co., Paul B., Philadelphia
Jenkins Bros., N. Y.
Nason Mfg. Co., N. Y.

Cocks, Steam
Dart Mfg. Co., E. M., Providence
Homestead (Pa.) Valve Mfg. Co.
Lunkenheimer Co., Cincinnati
Merco-Nordstrom Co., San Francisco

Combustion Chamber, Back Arch
American Arch Co., N. Y.
Detrick Co., M. H., Chicago
McLeod & Henry Co., Troy, N. Y.
Obermayer Co., S., Chicago
Walsh Fire Clay Products Co., St Louis

Combustion Control System
Boiler Engineering Co., Newark
Smoot Engr. Corp., N. Y.

CO_2 Recorders and Flue Gas Analysis Instruments
Foxboro Co., Foxboro
Huyette Co., Paul B., Philadelphia
Ohio Grease Co., Loudonville
Permutit Co., N. Y.
Republic Flow Meters Co., Chicago

Compressors, Air
Allis-Chalmers Mfg. Co., Milwaukee
Gardner Governor Co., Quincy
General Electric Co., Schenectady
Ingersoll-Rand Co., N. Y.
Nordberg Mfg. Co., Milwaukee
Worthington Pump & Machy. Corp., N. Y.

Compressors, Ammonia
Ingersoll-Rand Co., N. Y.
Worthington Pump & Machy. Corp., N. Y.

Compressors, Centrifugal
De Laval Steam Turbine Co., Trenton, N. J.

Compressors, Extraction
Sullivan Mchy. Co., Chicago

Compressors, Gas
Worthington Pump & Machy. Corp., N. Y.

Condensers
Allis-Chalmers Mfg. Co., Milwaukee
Elliott Co., Jeannette, Pa.
Ingersoll-Rand Co., N. Y.
Nordberg Mfg. Co., Milwaukee
Schutte-Koerting Co., Phila.
Wheeler Condenser & Engineering Co., Carteret, N. J.
Wheeler Mfg. Co., C. H., Phila.
Worthington Pump & Machy. Corp., N. Y.

Condensers, Barometric and Combined
Buffalo Steam Pump Co., Buffalo
Elliott Co., Jeannette, Pa.
Ingersoll-Rand Co., N. Y.
Wheeler Mfg. Co., C. H., Phila.
Worthington Pump & Mchy. Corp., N. Y.

Condensers, Jet
Elliott Co., Jeannette, Pa.
Ingersoll-Rand Co., N. Y.
Wheeler Mfg. Co., C. H., Phila.
Worthington Pump & Machy. Corp., N. Y.

Condensers, Surface
Alberger Heater Co., Buffalo
Bethlehem (Pa.) Steel Corp.
Elliott Co., Jeannette, Pa.
Ingersoll-Rand Co., N. Y.
Wheeler Mfg. Co., C. H., Phila.
Worthington Pump & Machy. Corp., N. Y.

Controllers, Draft
Engineer Co., N. Y.

Controllers, Electric
General Electric Co., Schenectady

Conveyors, Belt
Beaumont Co., R. H., Phila.
Brown Hoisting Machinery Co., Cleveland
Chain-Belt Co., Milwaukee
Gifford-Wood Co., Hudson, N. Y.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Chicago
Robins Conveying Belt Co., N. Y.
Webster Mfg. Co., Chicago

Conveyors, Portable
Gifford-Wood Co., Hudson, N. Y.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Chicago

Coolers, Generator
Griscom-Russell Co., N. Y.
Schutte-Koerting Co., Phila.
Spray Engineering Co., Boston
Sturtevant Co., B. F., Hyde Park

Coolers, Oil
Alberger Heater Co., Buffalo
Griscom-Russell Co., N. Y.
Schutte-Koerting Co., Phila.

Coolers, Water
Vogt Mach. Co., Henry, Louisville

Cooling Plants and Ponds
Schutte-Koerting Co., Phila.
Spray Engineering Co., Boston
Yarnall-Waring Co., Mermaid Ave., Phila.

Cooling Towers
Wheeler Condenser & Engineering Co., Carteret, N. J.
Wheeler Mfg. Co., C. H., Phila.

Couplings, Flexible Shaft
De Laval Steam Turbine Co., Trenton, N. J.
Foote Bros. Gear & Mach. Co., Chicago
Nicholson & Co., W. H., Wilkes-Barre
Philadelphia (Pa.) Gear Works
Terry Steam Turbine Co., Hartford

Couplings, Shaft
Foote Bros. Gear & Mach. Co., Chicago
Jeffrey Mfg. Co., Columbus, O.
Jones Fdry. & Mach. Co., W. A., Chicago
Nicholson & Co., W. H., Wilkes-Barre, Pa.

Covering, Pipe & Boilers
Keasbey & Mattison Co., Ambler, Pa.
Obermayer Co., S., Chicago

Cranes
Brown Hoisting Machinery Co., Cleveland
Milwaukee (Wis.) Electric Crane & Mfg. Co.

Cranes, Crawler Type
Link-Belt Co., Chicago

Cranes, Electric Traveling
Milwaukee (Wis.) Elect. Crane & Mfg. Co.

Cranes, Locomotive Gas
Brown Hoisting Machinery Co., Cleveland
Link-Belt Co., Chicago

Cranes, Locomotive Steam
Brown Hoisting Machinery Co., Cleveland

Cut Outs, Electric
General Electric Co., Schenectady

Cutters, Boiler Tubes
(See Pipe Cutters)

Cylinder Boring Bars and Reboring
Underwood Corp., H. B., Phila.

Dampers
Clarage Fan Co., Kalamazoo, Mich.

Deaerators
Cochrane Corp., Phila.
Elliott Co., Jeannette, Pa.
Griscom-Russell Co., N. Y.

Dealers Machinery
(See Searchlight Section)
Belyea Co., Inc.
Consolidated Products Co.
Fuerst-Friedman Co.
Land, L. J.
Lippincott Co.
Moore & MacDonald
Nashville Industrial Corp.
O'Brien Mchy. Co.
Power Mchy., Inc.
Randle Mchy. Co.
Ross Power Equipment Co.
Rockford Power Mchy. Co.
Sachsenmaier, Geo.
Scheinert Co., R.
Schwartz Boiler Co., C. M.
Stewart & Co.,
Wilson Machy. Co., Harold R.

Die Stocks
Curtis & Curtis Co., Bridgeport
Toledo (Ohio) Pipe Threading Mach.

Distilling Apparatus (Water)
Bethlehem (Pa.) Steel Corp.
Griscom-Russell Co., N. Y.

Doors, Ash Pit
Brady Conveyors Corp., Chicago

Draft, Mechanical
(See Blowers, Fan)

Drainers, Low Pressure
Cochrane Corp., Phila.

Dressing, Belt
Rhoads & Sons, J. E., Phila.

Drills
Chicago Pneu. Tool Co., N. Y.
Jeffrey Mfg. Co., Columbus, O.

Drop Forgings
Ingersoll-Rand Co., N. Y.
Vogt Mach. Co., Henry, Louisville

Dynamometers
Wheeler Mfg. Co., C. H., Phila.

Dynamos (See Generators)

Economizers
Alberger Heater Co., Buffalo
Green Fuel Economizer Co., Beacon, N. Y.
Power Specialty Co., N. Y.
Sturtevant Co., B. F., Hyde Park

Ejectors
Bethlehem (Pa.) Steel Corp.
Chaplin-Fulton Mfg. Co., Pittsburgh
Penberthy Injector Co., Detroit

Ejectors, Air
Elliott Co., Jeannette, Pa.

Electric Generating Sets, Steam Turbine
Allis-Chalmers Mfg. Co., Milwaukee
Elliott Co., Wellsville, N. Y.
General Electric Co., Schenectady
Moore Steam Turbine Corp., Wellsville, N. Y.
Ridgway (Pa.) Dynamo & Engine Co.
Sturtevant Co., B. F., Hyde Park
Terry Steam Turbine Co., Hartford

Elevators and Conveyors
Beaumont Co., R. H., Phila.
Brown Hoisting Machinery Co., Cleveland
Chain-Belt Co., Milwaukee
Gifford-Wood Co., Hudson, N. Y.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Chicago
Webster Mfg. Co., Chicago

Elevators, Bucket
Webster Mfg. Co., Chicago

Elevators, Factory
Ridgway & Fils Co., Craig, Coatesville, Pa.

Enamel
Wailes Dove-Hermiston Corp., N. Y.

Engine Repairs
Underwood Corp., H. B., Phila.

Engineering Service
(See Directory of Engineers)

Engines, Corliss
Allis-Chalmers Mfg. Co., Milwaukee
Chuse Engine & Mfg. Co., Mattoon, Ill.
Nordberg Mfg. Co., Milwaukee

Engines, Diesel
Anderson (Ind.) Engine & Fdry. Co.
Bethlehem (Pa.) Steel Corp.
Busch-Sulzer Bros.-Diesel Engine Co., St. Louis
Fulton Iron Works Co., St. Louis
Lombard Governor Co., Ashland, Mass.
McIntosh & Seymour Corp., Auburn, N. Y.
Nordberg Mfg. Co., Milwaukee
Worthington Pump & Machy. Corp., N. Y.

Engines, Gas and Oil
Allis-Chalmers Mfg. Co., Milwaukee
Anderson (Ind.) Engine & Fdry. Co.
Busch-Sulzer Bros.-Diesel Engine Co., St. Louis
Chicago Pneu. Tool Co., N. Y.
Fulton Iron Works Co., St. Louis
Ingersoll-Rand Co., N. Y.
Sterling Engine Co., Buffalo
Worthington Pump & Machy. Corp., N. Y.

Engines, Steam
Allis-Chalmers Mfg. Co., Milwaukee
Chicago Pneu. Tool Co., N. Y.
Chuse Engine & Mfg. Co., Mattoon, Ill.
Clarage Fan Co., Kalamazoo, Mich.
Erie City Iron Works, Erie, Pa.
Fulton Iron Works Co., St. Louis
Harrisburg (Pa.) Foundry & Machine Works
Nordberg Mfg. Co., Milwaukee
Ridgway (Pa.) Dynamo & Engine Co.
Skinner Engine Co., Erie
Sturtevant Co., B. F., Hyde Park
Troy (Pa.) Engine & Machine Co.

Engines, Steam Una-Flow
Chuse Engine & Mfg. Co., Mattoon, Ill.
Harrisburg (Pa.) Fdy. & Mch. Wks.
Nordberg Mfg. Co., Milwaukee
Skinner Engine Co., Erie

Evaporators
Bethlehem (Pa.) Steel Corp.
Griscom-Russell Co., N. Y.
Wheeler Condenser & Engineering Co., Carteret, N. J.

Exhaust Heads
Hoppes Mfg. Co., Springfield, Ohio
Sturtevant Co., B. F., Hyde Park
Wright-Austin Co., 321 W. Woodbridge St., Detroit

Exhausters, Gas
Sturtevant Co., B. F., Hyde Park

Expansion Joints
Griscom-Russell Co., N. Y.
Heward Iron Wks., Buffalo
Mogul Machine Co., Phila.
Wheeler Condenser & Engineering Co., Carteret, N. J.
Wheeler Mfg. Co., C. H., Phila.

Fans, Exhaust and Ventilator
(See Blowers, Fan)

Filters, Feed Water
Cochrane Corp., Phila.
Elliott Co., Jeannette, Pa.
Griscom-Russell Co., N. Y.

Filters, Oil
Elliott Co., Jeannette, Pa.
Nugent & Co., Wm. W., Chicago

Filters, Oil System
Nugent & Co., Wm. W., Chicago

Filters, Oil Removal
Griscom-Russell Co., N. Y.
Permutit Co., N. Y.

Filters, Pressure
Cochrane Corp., Phila.
Paige & Jones Chemical Co., Hammond, Ind.
Permutit Co., N. Y.

Filters, Water
Paige & Jones Chemical Co., Hammond, Ind.
Permutit Co., N. Y.

Firebox Blocks
Carborundum Co., Perth Amboy
McLeod & Henry Co., Troy, N. Y.
Walsh Fire Clay Products Co., St. Louis

Fire Hydrants
Howard Iron Wks., Buffalo

Fittings, Ammonia
Greene, Tweed & Co., N. Y.
Vogt Machine Co., Henry, Louisville
York Mfg. Co., York, Pa.

Fittings, Steel
Pittsburgh (Pa.) Piping & Equip. Co.

Flanges
American Spiral Pipe Works, Chicago
Dart Mfg. Co., E. M., Providence
Jefferson Union Co., Lexington, Mass.
Jenkins Bros., N. Y.
Pittsburgh (Pa.) Piping & Equip. Co.
Power Piping Co., Pittsburgh
Vogt Machine Co., Henry, Louisville

Floats
Hercules Float Wks., Springfield, Mass.

Flue Gas Analysis Recorders
Huyette Co., Paul B., Philadelphia

Foundations, Machinery
Ballard, Sprague & Co., N. Y.

Fuel Oil Systems
Bethlehem (Pa.) Steel Corp.
Combustion Engr. Corp., N. Y.
Engineer Co., N. Y.
Morse Dry Dock & Repair Co., Brooklyn
National Airoil Burner Co., Phila.
Peabody Engr. Corp., N. Y.

Furnace Arches
Bigelow Arch Co., Detroit
Burke Engineering Co., Holland, Mich.
Carborundum Co., Perth Amboy
Detrick Co., M. H., Chicago
Hofft Co., M. A., Indianapolis
Liptak Firebrick Arch Co., Mexico, Mo.
McLeod & Henry Co., Troy, N. Y.
Obermayer Co., S., Chicago
Queen's Run Refractories Co., Lock Haven, Pa.

Furnace Bottoms
Furnace Engineering Co., N. Y.

Furnace Bottoms, Cast Iron Air Cooled
Allen, Sherman, Hoff Co., Phila.

Furnace Construction
Cement-Gun Co., Allentown, Pa.
Plibrico Jointless Fire Brick Co., Chicago

Furnace Linings
Ashland (Ky.) Fire Brick Co.
Botfield Refractories Co., Phila.
Carborundum Co., Perth Amboy
Cement-Gun Co., Allentown, Pa.
General Refractories Co., Phila.
Keystone Refractories Co., N. Y.
Laclede-Christy, St. Louis
McLeod & Henry Co., Troy, N. Y.
Obermayer Co., S., Chicago
Plibrico Jointless Fire Brick Co., Chicago
Queen's Run Refractories Co., Lock Haven, Pa.
Walsh Fire Clay Products Co., St. Louis

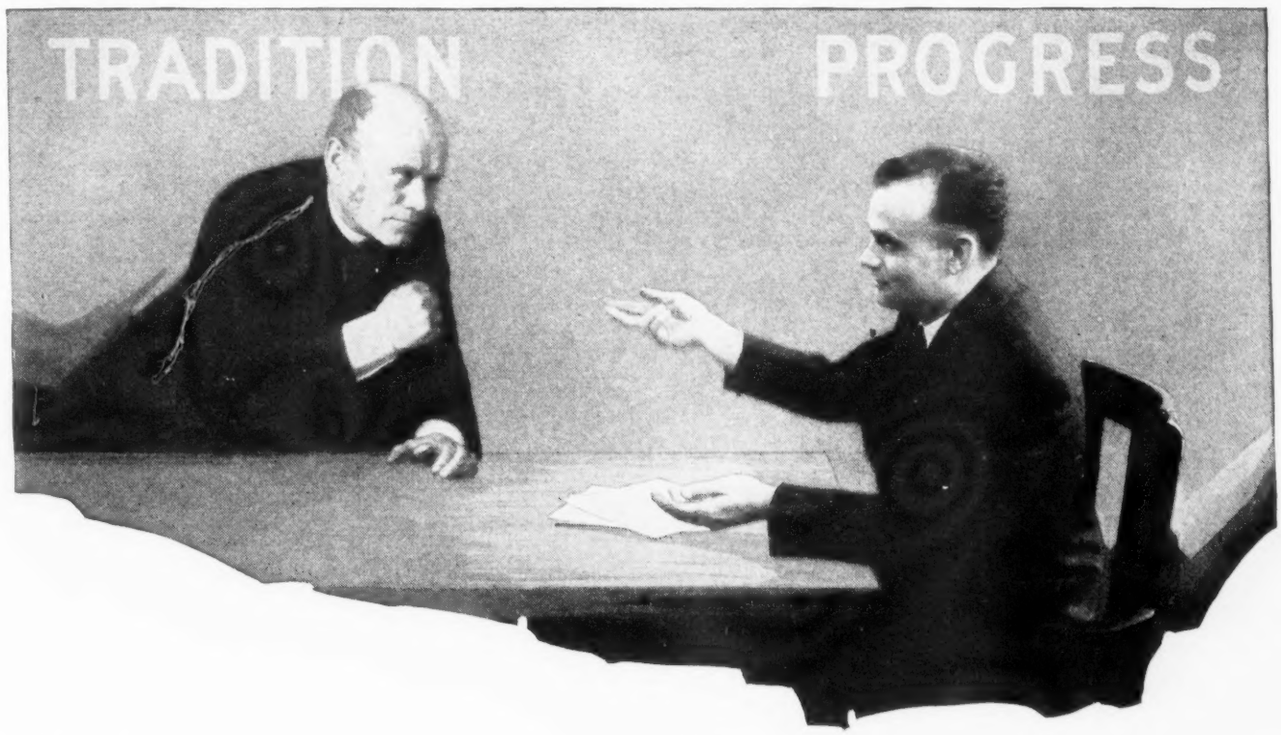
Furnaces
Burke Engineering Co., Holland, Mich.
Combustion Engineering Corp., N. Y.
Detroit Stoker Co., Detroit
Erie City Iron Wks., Erie, Pa.
Fuller-Lehigh Co., Fullerton, Pa.
Hofft Co., M. A., Indianapolis
Illinois Stoker Co., Alton, Ill.
McClave-Brooks Co., Scranton, Pa.

Furnaces, Bagasse & Wood Burning
Combustion Engineering Corp., N. Y.
Detrick Co., M. H., Chicago
McClave-Brooks Co., Scranton, Pa.

Furnaces, Incinerator
Combustion Engineering Corp., N. Y.
McClave-Brooks Co., Scranton, Pa.

Furnaces, Water Cooled
Furnace Engineering Co., N. Y.

Pop Cusses and Lad Discusses Insulation



"Lad—

if we had in the bank all the money we lost in machine shutdowns due to motor troubles last year, we could endow a primary election. Felix tells me it's all due to the wrong kind of insulation."

"No, Pop—

it's all due to the wrong kind of motors.

In all those shutdowns last year, read the names of the motors.

You don't see a Linc-Weld saying HERE to that mussy roll.

Those two Linc-Weld motors I bought over your objections had the hardest jobs in the plant and today their insulation is pliable as your ear lobe.

The Lincoln people have always led the field on insulation."

Read on Page 11 of the Motor book just why no motor can hope to beat Linc-Weld on this item. Your copy is waiting for you at:

Dept. 2-12.

The Lincoln Electric Company, Cleveland, Ohio

MA-4

"Linc-Weld"

LINCOLN MOTOR

Fuses
General Electric Co., Schenectady
Gage Glass Guards & Shields
Chesterton Co., A. W., Boston
Huyette Co., Paul B., Philadelphia
Jenkins Bros., N. Y.

Gage Glasses
Jenkins Bros., N. Y.
Libbey Glass Mfg. Co., Toledo, Ohio

Gages, Differential
Bailey Meter Co., Cleveland
Republic Flow Meters Co., Chicago

Gages, Draft
Bailey Meter Co., Cleveland
Bristol Co., Waterbury, Conn.
Peabody Engr. Corp., N. Y.
Republic Flow Meters Co., Chicago

Gages, Pressure
American Schaeffer & Budenberg Corp., Brooklyn
Bristol Co., Waterbury, Conn.
Crosby Steam Gage & Valve Co., Boston
Republic Flow Meters Co., Chicago

Gages, Recording
American Schaeffer & Budenberg Corp., Brooklyn
Crosby Steam Gage & Valve Co., Boston
Republic Flow Meters Co., Chicago

Gages, Vacuum
Bristol Co., Waterbury, Conn.
Crosby Steam Gage & Valve Co., Boston
Greene, Tweed & Co., N. Y.

Gages, Water
Greene, Tweed & Co., N. Y.
Jenkins Bros., N. Y.

Gas Burning Equipment
Mettler Co., Lee B., Los Angeles

Gas Exhausters
General Electric Co., Schenectady

Gaskets
Garlock Packing Co., Palmyra, N. Y.
Greene, Tweed & Co., N. Y.
Jenkins Bros., N. Y.
Keasbey & Mattison Co., Ambler, Pa.
Smooth-On Mfg. Co., Jersey City N. J.
U. S. Rubber Co., N. Y.

Gates, Blast
Rockwell Co., W. S., N. Y.

Gates, Coal & Ash Bin
Allen, Sherman, Hoff Co., Phila.
Beaumont Co., R. H., Phila.
Brown Hoisting Machinery Co., Cleveland
Chain-Belt Co., Milwaukee
Gifford-Wood Co., Hudson, N. Y.
Hunt Co., C. W., West New Brighton, N. Y.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Chicago
Webster Mfg. Co., Chicago

Gears
Foote Bros. Gear & Mach. Co., 233 No. Curtis St., Chicago
Ganschow Co., Wm., Chicago
General Electric Co., Schenectady
James Mfg. Co., So. Chicago
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Chicago
Jones Fdry. & Mach. Co., W. A., Chicago
Philadelphia (Pa.) Gear Works
Webster Mfg. Co., Chicago

Gears, Double Helical
De Laval Steam Turbine Co., Trenton, N. J.
Foote Bros. Gear & Mach. Co., Chicago

Gears, Reduction
De Laval Steam Turbine Co., Trenton, N. J.
Elliott Co., Wellsville, N. Y.
Foote Bros. Gear & Mach. Co., 233 No. Curtis St., Chicago
Ganschow Co., Wm., Chicago
Jones Fdry. & Mach. Co., W. A., Chicago
Moore Steam Turbine Corp., Wellsville, N. Y.
Philadelphia (Pa.) Gear Works

Generating Sets
General Electric Co., Schenectady
Ridgway (Pa.) Dynamo & Engine Co.
Sturtevant Co., B. F., Hyde Park

Generators, Electric
General Electric Co., Schenectady
Sturtevant Co., B. F., Hyde Park

Governors, Pump
Atlas Valve Co., Newark, N. J.
Chaplin-Fulton Mfg. Co., Pittsburgh
Davis Regulator Co., G. M., Chicago
Northern Equipment Co., Erie, Pa.
S.-C. Regulator Mfg. Co., Fostoria, O.
Squires Co., C. E., Cleveland
Strong, Carlisle & Hammond Co., Cleveland
Watts Regulator Co., Lawrence, Mass.
Wright-Austin Co., 321 W. Woodbridge St., Detroit

Governors, Water-Wheel
Lombard Governor Co., Ashland, Mass.

Graphite
Greene, Tweed & Co., N. Y.
United States Graphite Co., Saginaw, Mich.

Grate Bars and Clips
Bethlehem (Pa.) Shipbuilding Corp.
Burke Engineering Co., Holland, Mich.
Furnace Engineering Co., N. Y.
Riley Stoker Corp., Worcester

Grates
Armstrong Mfg. Co., Springfield, O.
Babcock & Wilcox Co., N. Y.
CoKal Stoker Corp., Chicago
Combustion Engr. Corp., N. Y.
Cyclone Grate Bar Co., Buffalo
Erie City Iron Wks., Erie, Pa.
Flynn & Emrich Co., Baltimore
Furnace Engineering Co., N. Y.
Kelly Foundry & Mach. Co., Goshen, Ind.
McClave-Brooks Co., Scranton, Pa.
Neemes Fdry., Inc., Troy
Riley Stoker Corp., Worcester
Vogt Mach. Co., Henry, Louisville

Grates, Round
McClave-Brooks Co., Scranton, Pa.

Grating, Steel
Blaw-Knox Co., Pittsburgh

Greases
Ohio Grease Co., Loudonville

Grease Extractors
Elliott Co., Jeannette, Pa.

Grinders, Air & Electric, Portable
Chicago Pneumatic Tool Co., N. Y.

Hammers, Pneumatic
Chicago Pneumatic Tool Co., N. Y.
Ingersoll-Rand Co., N. Y.

Heaters, Air
Babcock & Wilcox Co., N. Y.
Combustion Engineering Corp., N. Y.

Heaters, Deaerating
Cochrane Corp., Phila.
Elliott Co., Jeannette, Pa.

Heaters, Domestic
Alberger Heater Co., Buffalo

Heaters, Feed Water
Alberger Heater Co., Buffalo
Bethlehem (Pa.) Steel Corp.
Cochrane Corp., Phila.
Elliott Co., Jeannette, Pa.
Erie City Iron Wks., Erie, Pa.
Griscom-Russell Co., N. Y.
Hoppes Mfg. Co., Springfield, Ohio
Neemes Fdry., Inc., Troy
Patterson-Kelley Co., N. Y.
Permutit Co., N. Y.
Ross Heater & Mfg. Co., Buffalo
Schutte-Koerting Co., Phila.
Wheeler Condenser & Engineering Co., Carteret, N. J.

Heaters, Hot Water Service
Patterson Kelley Co., N. Y.

Heaters, Metering
Cochrane Corp., Phila.

Heaters, Oil
Alberger Heater Co., Buffalo
Griscom-Russell Co., N. Y.
Patterson-Kelley Co., N. Y.
Power Specialty Co., N. Y.

Heaters, Steam Stack
Cochrane Corp., Phila.

Heaters, Storage
Cochrane Corp., Phila.
Patterson-Kelley Co., N. Y.

Heating and Ventilating Systems
Buffalo Forge Co., Buffalo
Clarage Fan Co., Kalamazoo, Mich.
Sturtevant Co., B. F., Hyde Park

Hoists, Air
Chicago Pneumatic Tool Co., N. Y.
Lagonda Mfg. Co., Springfield, Ohio

Hoists, Electric
Beaumont Co., R. H., Phila.

Hoppers, Coal and Ash
Allen, Sherman, Hoff Co., Phila.
Beaumont Co., R. H., Phila.
Chain-Belt Co., Milwaukee
Combustion Engineering Corp., N. Y.
Gifford-Wood Co., Hudson, N. Y.
Jeffrey Mfg. Co., Columbus, O.
Republic Flow Meters Co., Chicago

Hoppers, Coal and Ash
Webster Mfg. Co., Chicago

Hose, Air
Chicago Pneumatic Tool Co., N. Y.
Lagonda Mfg. Co., Springfield, Ohio
Liberty Mfg. Co., Pittsburgh

Hose, Rubber
Quaker City Rubber Co., Wissinoming, Phila.
U. S. Rubber Co., N. Y.

Hose, Seamless, Metal
Cory & Son, Chas., N. Y.

Hose, Steam
Lagonda Mfg. Co., Springfield, Ohio
Liberty Mfg. Co., Pittsburgh

Hose, Tube Cleaner
Lagonda Mfg. Co., Springfield, Ohio
Liberty Mfg. Co., Pittsburgh

Hose, Water
Lagonda Mfg. Co., Springfield, Ohio
Liberty Mfg. Co., Pittsburgh

Hose, Welding
Oxweld Acetylene Co., N. Y.

Ice Machine Repairs
Underwood Corp., H. B., Phila.

Ice and Refrigerating Machinery
(See Refrigerating Machinery)

Illuminators, Water Column
Simplex Valve & Meter Co., Philadelphia

Illuminators, Gage
Simplex Valve & Meter Co., Philadelphia

Indicators, Floor
Hanson, Roy E., Los Angeles

Indicators, Speed
Biddle, James G., Phila.
Zernickow Co., O., N. Y.

Indicators, Steam Engine
Crosby Steam Gage & Valve Co., Boston
Manning, Maxwell & Moore, N. Y.

Indicators, Valve Position
Northern Equipment Co., Erie, Pa.

Injectors
Jenkins Bros., N. Y.
Penberthy Injector Co., Detroit
Schutte-Koerting Co., Phila.

Intercoolers
Griscom-Russell Co., N. Y.

Lamps, Arc
General Electric Co., Schenectady

Lamps, Incandescent
General Electric Co., Schenectady

Lubricants
Empire Refineries, Inc., Tulsa

Lubricators, Cylinder
Bowser & Co., S. F., Ft. Wayne
Ohio Grease Co., Loudonville

Lubricators, Force Feed
Bowser & Co., S. F., Ft. Wayne
Greene, Tweed & Co., N. Y.
Lunkenheimer Co., Cincinnati
Manzel Bros. Co., Buffalo
Penberthy Injector Co., Detroit
Powell Co., Wm., Cincinnati

Metal Bearings
Hoyt Metal Co., St. Louis

Meters, Air
Bailey Meter Co., Cleveland
Cochrane Corp., Phila.
General Electric Co., Schenectady
Republic Flow Meters Co., Chicago

Meters, Boiler
Bailey Meter Co., Cleveland
Republic Flow Meters Co., Chicago

Meters, Coal
Bailey Meter Co., Cleveland
Republic Flow Meters Co., Chicago

Meters, Electric
General Electric Co., Schenectady

Meters, Feed Water
Bailey Meter Co., Cleveland
Cochrane Corp., Phila.
General Electric Co., Schenectady
Republic Flow Meters Co., Chicago
Yarnall-Waring Co., Mermaid Ave., Phila.

Meters, Flow
Bailey Meter Co., Cleveland
Cochrane Corp., Phila.
General Electric Co., Schenectady
Republic Flow Meters Co., Chicago
Yarnall-Waring Co., Mermaid Ave., Phila.

Meters, Gas
Bailey Meter Co., Cleveland
Cochrane Corp., Phila.
General Electric Co., Schenectady
Republic Flow Meters Co., Chicago

Meters, Oil
Cochrane Corp., Phila.
General Electric Co., Schenectady
Republic Flow Meters Co., Chicago
Worthington Pump & Machy. Corp., N. Y.

Meters, Steam
Bailey Meter Co., Cleveland
Cochrane Corp., Phila.
General Electric Co., Schenectady
Republic Flow Meters Co., Chicago

Meters V-Notch
Bailey Meter Co., Cleveland
Cochrane Corp., Phila.
Yarnall-Waring Co., Mermaid Ave., Phila.

Meters, Volumetric
Cochrane Corp., Phila.

Meters, Water
Cochrane Corp., Phila.
Cory & Son, Chas., N. Y.
General Electric Co., Schenectady
Hoppes Mfg. Co., Springfield, Ohio
Worthington Pump & Machy. Corp., N. Y.
Yarnall-Waring Co., Mermaid Ave., Phila.

Meters, Weighing
Cochrane Corp., Phila.

Motors, Electric
Allis-Chalmers Mfg. Co., Milwaukee
General Electric Co., Schenectady
Lincoln Electric Co., Cleveland

Motors, Water
Roto Co., Hartford, Conn.

Nitrogen
Linde Air Products Co., N. Y.

Oil Diesel Engine
Empire Refineries, Inc., Tulsa

Oil, Fuel
Empire Refineries, Inc., Tulsa

Oil and Grease Cups
Lunkenheimer Co., Cincinnati
Ohio Grease Co., Londonville
Penberthy Injector Co., Detroit
Powell Co., Wm., Cincinnati

Oil, Lubricating
Empire Refineries, Inc., Tulsa

Oil Purifiers, Centrifugal
De Laval Steam Turbine Co., Trenton, N. J.

Oil Reclaimers
Bowser & Co., S. F., Ft. Wayne
De Laval Separator Co., N. Y.

Oil Storage Equipment
Bowser & Co., S. F., Fort Wayne, Ind.

Oilers, Sight Feed and Multiple
Bowser & Co., S. F., Ft. Wayne
Lunkenheimer Co., Cincinnati
Nugent & Co., Wm. W., Chicago

Oilers, Telescopic and Centrifugal
Bowser & Co., S. F., Ft. Wayne
Nugent & Co., Wm. W., Chicago

Oiling Devices and Systems
Bowser & Co., S. F., Ft. Wayne
Manzel Bros. Co., Buffalo
Nugent & Co., Wm. W., Chicago

Oxygen, Gas
Linde Air Products Co., N. Y.

Packing, Asbestos
Garlock Packing Co., Palmyra, N. Y.
Keasbey & Mattison Co., Ambler, Pa.

Packing, Cylinder
Chesterton Co., A. W., Boston

Packing, Flax
Chesterton Co., A. W., Boston
Garlock Packing Co., Palmyra, N. Y.

Packing for Rotating Shafts
Cooke Seal Ring, Chicago

Packing, Hydraulic
Garlock Packing Co., Palmyra, N. Y.

Packing, Metallic
France Packing Co., Philadelphia
Garlock Packing Co., Palmyra, N. Y.

Packing Metallic Flexible
France Packing Co., Philadelphia
Garlock Packing Co., Palmyra, N. Y.

Packing, Piston
Chesterton Co., A. W., Boston
Garlock Packing Co., Palmyra, N. Y.
Johns-Pratt Co., Hartford
U. S. Rubber Co., N. Y.

Packing Pump Valve
Garlock Packing Co., Palmyra, N. Y.

Packing, Rod
Garlock Packing Co., Palmyra, N. Y.
Greene, Tweed & Co., N. Y.
N. Y. Belting & Packing Co., N. Y.
Quaker City Rubber Co., Wissinoming, Phila.
U. S. Rubber Co., N. Y.

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The value of a commodity is its definite worth measured in the terms of proper service under given conditions.
For many years Garlock Packings have been rendering efficient and economical service. This performance has established for Garlock Products a known Value and has gained for them the Confidence of Buyers and Users of Mechanical Packings.

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Garlock Packing Co., Palmyra, N. Y.
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Jenkins Bros., N. Y.
Keasbey & Mattison Co, Ambler, Pa.
N. Y. Belting & Packing Co., N. Y.
Quaker City Rubber Co., Wissinoming, Phila.
U. S. Rubber Co., N. Y.

Packing, Valve Stem
Garlock Packing Co., Palmyra, N. Y

Paints, Industrial
Wailes Dove-Hermiston Corp., N. Y.

Pipe
Midwest Piping & Supply Co., St. Louis
Power Piping Co., Pittsburgh

Pipe Bending
American Pipe Bending Mach. Co., Boston
National Valve & Mfg. Co., Pittsburgh
Pittsburgh (Pa.) Piping & Equip. Co.
Power Piping Co., Pittsburgh

Pipe Coils
Abendroth & Root Mfg. Co., N. Y.

Pipe Cutting and Threading Machines
Curtis & Curtis Co., Bridgeport
Jefferson Union Co., Lexington, Mass
Pittsburgh (Pa.) Piping & Equip. Co.
Power Piping Co., Pittsburgh
Toledo (Ohio) Pipe Threading Mach. Co.
Trimont Mfg. Co., Roxbury

Pipe Spiral, Riveted
Abendroth & Root Mfg. Co., N. Y.
American Spiral Pipe Works, Chicago

Piping Contractors
Baker & Co., R. H., Cambridge
Midwest Piping & Supply Co., St. Louis
National Valve & Mfg. Co., Pittsburgh
Pittsburgh (Pa.) Piping & Equip., Co.
Pittsburgh (Pa.) Valve Fdry. & Constr. Co.
Power Piping Co., Pittsburgh

Piping, Fabricators
Midwest Piping & Supply Co., St. Louis

Piping, High Pressure
Baker & Co., R. H., Cambridge
Midwest Piping & Supply Co. St. Louis
National Valve & Mfg. Co., Pittsburgh
Pittsburgh (Pa.) Piping & Equip., Co.
Pittsburgh (Pa.) Valve Fdry. & Constr. Co.
Power Piping Co., Pittsburgh

Pneumatic Tools
Ingersoll-Rand Co., N. Y.

Power Transmission Machinery
Allis-Chalmers Mfg. Co., Milwaukee
Foote Bros. Gear & Mach. Co., Chicago
Jeffrey Mfg. Co., Columbus, O.
Jones Fdry. & Mach. Co., W. A., Chicago
Link-Belt Co., Chicago
Morse Chain Co., Ithaca, N. Y.
Webster Mfg. Co., Chicago

Pre-Heaters, Air
Buffalo Forge Co., Buffalo
Combustion Engineering Corp., N. Y.

Pulleys
Greene, Tweed & Co., N. Y.
Jones Fdry. & Mach. Co., W. A., Chicago
Link-Belt Co., Chicago

Pulleys, Magnetic
Acme Magnetic Pulley Co., Chicago
Magnetic Mfg. Co., Milwaukee

Pulverized Coal Equipment
Bethlehem (Pa.) Steel Co.
Combustion Engr. Corp., N. Y.
Erie City Iron Works, Erie, Pa.
Fuller-Lehigh Co., Fullerton, Pa.
Furnace Engineering Co., N. Y.
Illinois Stoker Co., Alton
Jeffrey Mfg. Co., Columbus, O.
Kennedy-Van Saun Mfg. & Eng. Corp., N. Y.
Riley Stoker Corp., Worcester, Mass.

Pulverizers, Coal
Kennedy-Van Saun Mfg. & Eng. Corp., N. Y.

Pumps, Air
Elliott Co., Jeannette, Pa.
Wheeler Condenser & Eng. Co., N.Y.
Wheeler Mfg. Co., C. H., Phila.

Pumps, Boiler Feed
Allis-Chalmers Mfg. Co., Milwaukee
Bethlehem (Pa.) Steel Corp.
Buffalo Steam Pump Co., Buffalo
Coppus Engineering Corp., Worcester, Mass.
Dean Hill Pump Co., Anderson, Ind.
De Laval Steam Turbine Co., Trenton, N. J.
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Wks.), N. Y.
Lecourtenay Co., Newark, N. J.
Moore Steam Turbine Corp., Wellsville, N. Y.
National Tube Co., Pittsburgh
Platt Iron Wks., Dayton, Ohio
Warren (Mass.) Steam Pump Co., Inc.
Worthington Pump & Machy. Corp., N. Y.

Pumps, Centrifugal
Allis-Chalmers Mfg. Co., Milwaukee
Bethlehem (Pa.) Steel Corp.
Buffalo Steam Pump Co., Buffalo
Dean Bros. Co., Indianapolis
Dean Hill Pump Co., Anderson, Ind.
De Laval Steam Turbine Co., Trenton, N. J.
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Wks.), N. Y.
Lecourtenay Co., Newark, N. J.
Manistee (Mich.) Iron Works Co.
Moore Steam Turbine Corp., Wellsville, N. Y.
National Tube Co., Pittsburgh
Warren (Mass.) Steam Pump Co., Inc.
Worthington Pump & Machy. Corp., N. Y.

Pumps, Condenser
Elliott Co., Jeannette, Pa.
Wheeler Mfg. Co., C. H., Phila.

Pumps, Fuel Oil Service
Bethlehem (Pa.) Steel Corp.
Dean Bros. Co., Indianapolis
Warren (Mass.) Steam Pump Co., Inc.

Pumps, Mine
Allis-Chalmers Mfg. Co., Milwaukee
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Wks.), N. Y.

Pumps, Oil
Bowser & Co., S. F., Ft. Wayne
Dean Bros. Co., Indianapolis
Nugent & Co., Wm. W., Chicago

Pumps, Power
Aldrich Pump Co., Allentown, Pa.
Dean Bros. Co., Indianapolis
Platt Iron Works, Dayton, Ohio
Warren (Mass.) Steam Pump Co., Inc.
Worthington Pump & Machy. Corp., N. Y.

Pumps, Rotary
Wheeler Mfg. Co., C. H., Phila.

Pumps, Steam
Aldrich Pump Co., Allentown, Pa.
Dean Bros. Co., Indianapolis
Dean Hill Pump Co., Anderson, Ind.
Fairbanks, Morse & Co., Chicago
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Wks.), N. Y.
Manistee (Mich.) Iron Works Co.
Warren (Mass.) Steam Pump Co., Inc.
Worthington Pump & Machy. Corp., N. Y.

Pumps, Turbine
Allis-Chalmers Mfg. Co., Milwaukee
Bethlehem (Pa.) Shipbuilding Corp.
Dean Hill Pump Co., Anderson, Ind.
Elliott Co., Wellsville, N. Y.
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Works) N. Y.
Moore Steam Turbine Corp., Wellsville, N. Y.
Terry Steam Turbine Co., Hartford

Pumps, Vacuum
Elliott Co., Jeannette, Pa.
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Wks.), N. Y.
Warren (Mass.) Steam Pump Co.
Wheeler Mfg. Co., C. H., Phila.
Worthington Pump & Machy. Corp., N. Y.

Pumps, Water-Works
Allis-Chalmers Mfg. Co., Milwaukee
Buffalo Steam Pump Co., Buffalo
Murray Iron Wks. Co., Burlington
Worthington Pump & Machy. Corp., N. Y.

Purifiers, Feed Water
Cochrane Corp., Phila., Pa.
Griscom-Russell Co., N. Y.
Hoppes Mfg. Co., Springfield, Ohio
Permutit Co., N. Y.
Yarnall-Waring Co., Mermaid Ave., Phila., Pa.

Purifiers, Oil
Bowser & Co., S. F., Ft. Wayne
De Laval Separator Co., N. Y.

Purifiers, Steam
Andrews Brad-haw Co., Pittsburgh
Cochrane Corp., Phila.

Pyrometers
Bristol Co., Waterbury
Leeds & Northrup Co., Phila.
Republic Flow Meters Co., Chicago
Taylor Instrument Co.'s, Rochester

Recorders, Draft
Republic Flow Meters Co., Chicago

Recorders, Pressure
Crosby Steam Gage & Valve Co., Boston
Taylor Instrument Co.'s, Rochester

Recorders, Vacuum
Crosby Steam Gage & Valve Co., Boston

Refrigerating Machinery
Ingersoll-Rand Co., N. Y.
Vogt Machine Co., Henry, Louisville
York Mfg. Co., York, Pa.

Regulators, Blower
McClave-Brooks Co., Scranton, Pa.

Regulators, Damper, Draft and Fan
Atlas Valve Co., Newark, N. J.
Hagan Corp., Pittsburgh
Smoot Engr. Corp., N. Y.
Watts Regulator Co., Lawrence, Mass.

Regulators, Feed Water
Atlas Valve Co., Newark, N. J.
Mason Regulator Co., Boston
Northern Equipment Co., Erie, Pa.
S-C Regulator Mfg. Co., Fostoria, O.
Squires Co., C. E., Cleveland
Watts Regulator Co., Lawrence, Mass.

Regulators, Gas
Davis Regulator Co., G. M., Chicago

Regulators, Pressure
Chaplin-Fulton Mfg. Co., Pittsburgh
Davis Regulator Co., G. M., Chicago
Engineer Co., N. Y.
Mason Regulator Co., Boston
Northern Equipment Co., Erie, Pa.
Squires Co., C. E., Cleveland
Taylor Instrument Co.'s, Rochester

Regulators, Pump
Mason Regulator Co., Boston
Northern Equipment Co., Erie, Pa.
Squires Co., C. E., Cleveland
Strong, Carlisle & Hammond, Cleveland
Watts Regulator Co., Lawrence, Mass.

Regulators, Temperature
Sarco Co., Inc., N. Y.
Taylor Instrument Co.'s, Rochester

Reservoirs, Oil
Bowser & Co., S. F., Ft. Wayne

Rheostats
General Electric Co., Schenectady

Rope Transmission
Hunt Co., C. W., West New Brighton, N. Y.

Rubber Goods
N. Y. Belting & Packing Co., N. Y.
Quaker City Rubber Co., Wissinoming, Phila.

Scale Removers
Lagonda Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburgh
Roto Co., Hartford, Conn.

Schools, Combustion
Hays Institute, Chicago

Screens, Shaking and Revolving
Chain-Belt Co., Milwaukee
Gifford-Wood Co., Hudson, N. Y.

Screens, Water Intake
Chain-Belt Co., Milwaukee
Link Belt Co., Chicago

Second-Hand Equipment (See Searchlight Section)
Belyea Co., Inc.
Consolidated Products Co.
Fuerst-Friedman Co.
Land, L. J.
Lippincott Co.
Moore & MacDonald
Nashville Industrial Corp.
O'Brien Mchy. Co
Power Mchy., Inc.
Randle Mchy. Co.
Rockford Power Mchy. Co.
Ross Power Equipment Co
Sachsenmaier, Geo.
Scheinert Co., R.
Schwartz Boiler Co., C. M.
Stewart & Co.,
Wilson Machy. Co., Harold R.

Separators, Air
Cochrane Corp., Phila.
Elliott Co., Jeannette, Pa.

Separators, Ammonia
Cochrane Corp., Phila
Elliott Co., Jeannette, Pa.
Gifford-Wood Co., Hudson, N. Y.

Separators, Magnetic
Acme Magnetic Pulley Co., Chicago
Magnetic Mfg. Co., Milwaukee

Separators, Oil
Cochrane Corp., Phila.
De Laval Separator Co., N. Y.
Elliott Co., Jeannette, Pa.
Griscom-Russell Co., N. Y.
Wright-Austin Co., 321 W. Woodbridge St., Detroit

Separators, Receiver
Cochrane Corp., Phila.

Separators, Steam
Andrews, Bradshaw Co., Pittsburgh
Cochrane Corp., Phila.
Elliott Co., Jeannette, Pa.
Griscom-Russell Co., N. Y.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Strong, Carlisle & Hammond, Cleveland
Wright-Austin Co., 321 W. Woodbridge St., Detroit

Shaft Packing Rings
Cooke Seal Ring, Chicago

Skimmers, Boiler
Yarnall-Waring Co., Mermaid Ave., Phila.

Special Machine Work
Howard Iron Wks., Buffalo

Speed Reducers
De Laval Steam Turbine Co., Trenton, N. J.
Foote Bros. Gear & Mach. Co., Chicago
Morse Chain Co., Ithaca, N. Y.
Philadelphia (Pa.) Gear Works

Spray Nozzles
(See Cooling Plants and Ponds)

Stacks, Brick
Custodis Chimney Constr. Co., Alphons, N. Y.
Rust Engineering Co., Pittsburgh

Stacks, Concrete
Rust Engineering Co., Pittsburgh

Stacks, Metal
Erie City Iron Wks., Erie, Pa.
Heine Boiler Co., St. Louis
Littleford Bros., Cincinnati
Smith & Son Co., S., Paterson, N. J
Union Iron Works, Erie, Pa.
Walsh & Weidner Boiler Co., Chattanooga

Stacks, Radial Brick
American Chimney Corp., N. Y.
Ballard, Sprague & Co., N. Y.
Custodis Chimney Constr. Co., Alphons, N. Y.

Steel Plate Work
Heine Boiler Co., St. Louis
Murray Iron Wks. Co., Burlington
Union Iron Wks., Erie, Pa.

Stoker Repairs
Furnace Engineering Co., N. Y.

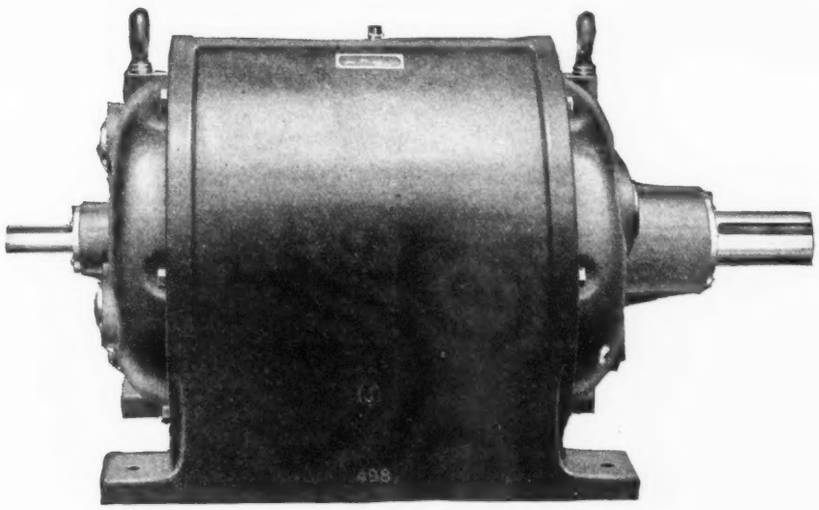
Stokers, Chain and Traveling Grate
Babcock & Wilcox Co., N. Y.
Burke Engineering Co., Holland, Mich.
Combustion Engineering Corp., N. Y.
Illinois Stoker Co., Alton, Ill.
Laclede Stoker Co., St. Louis, Mo.
McClave-Brooks Co., Scranton, Pa.
Riley Stoker Corp., Worcester
Rosedale Fdry. & Mach. Co., Pittsburgh

Stokers, Forced Draft
American Engineering Co., Phila.
Combustion Engineering Corp., N. Y.
Detroit Stoker Co., Detroit
Flynn & Emrich, Baltimore
Hart Stoker, Ltd., Philadelphia
Illinois Stoker Co., Chicago
McClave-Brooks Co., Scranton Pa.
Neemes Foundry Inc., Troy
Riley Stoker Corp., Worcester, Mass.

Stokers, Hand Operated
Armstrong Mfg. Co., Springfield, O.
Burke Engineering Co., Holland, Mich.
CoKal Stoker Corp., Chicago
Combustion Engineering Corp., N. Y.
Flynn & Emrich Co., Baltimore
McClave-Brooks Co., Scranton, Pa.
Riley Stoker Corp., Worcester
Hofft Co., M. A., Indianapolis

Stokers, Hopper Fed
CoKal Stoker Corp., Chicago
Flynn & Emrich Co., Baltimore

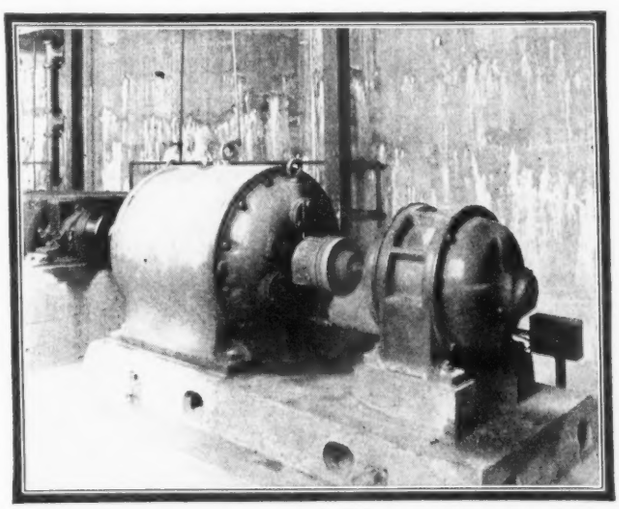
Stokers, Hopper Feed Hand Operated
CoKal Stoker Corp., Chicago



The Balanced Straight Line Drive

Power economy recommends the high speed electric motor and the unit drive—a motor to its machine. Power economy recommends also the transmission of power in the most direct manner possible from the high speed electric motor to the slower moving driven machine.

With the Jones Spur Gear Speed Reducer the power economies of the electric motor and the unit drive are augmented by the balanced straight line drive principle. The motor shaft, high and low speed reducer shafts, and the shaft of the driven unit are all in the same straight line. Motor shafts and driven shafts are relieved of flexural strains and stresses, eliminating heavy transverse loads on bearings, journals and supports. The relatively few parts in the Jones Spur Gear Speed Reducer simplify and permit better mechanical construction. This means longer, carefree service. The gears inside the dust-proof housing operate in an oil bath under ideal conditions.



Hundreds of engineers, operators and users of the Jones Spur Gear Speed Reducers in all lines of industry are unanimous in their belief that it is the most economical drive. For complete information write for Speed Reducer Catalog No. 26.

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and Power Transmitting Machinery

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McClave-Brooks Co., Scranton, Pa.

Stokers, Hopper Feed, Power Operated
CoKal Stoker Corp., Chicago

Stokers, Mechanical
American Engineering Co., Phila.
Babcock & Wilcox Co., N. Y.
Burke Engineering Co., Holland, Mich.
Combustion Engineering Corp., N. Y.
Detroit Stoker Co., Detroit
Flynn & Emrich Co., Baltimore
Hart Stoker, Ltd., Philadelphia
Illinois Stoker Co., Chicago
McClave-Brooks Co., Scranton, Pa.
Riley Stoker Corp., Worcester, Mass.

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Armstrong Mfg. Co., Springfield, O.
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Flynn & Emrich Co., Baltimore
McClave-Brooks Co., Scranton, Pa.
Riley Stoker Corp., Worcester, Mass.

Stokers, Underfeed, Multiple Retort
American Engineering Co., Phila.
Combustion Engr. Corp., N. Y.
Detroit Stoker Co., Detroit
Riley Stoker Corp., Worcester

Stokers, Underfeed, Single Retort
Combustion Engr. Corp., N. Y.
Detroit Stoker Co., Detroit
Hart Stoker, Ltd., Philadelphia
Riley Stoker Corp., Worcester
Sturtevant Co., B. F., Hyde Park

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Gas Combustion Co., Pittsburgh
Strong, Carlisle & Hammond Co., Cleveland

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Bowser & Co., S. F., Ft. Wayne
Elliott Co., Jeannette, Pa.
Griscom-Russell Co., N. Y.
Sarco Co., Inc., N. Y.

Strainers, Pump Suction
Elliott Co., Jeannette, Pa.

Strainers, Water
Elliott Co., Jeannette, Pa.
Rosedale Fdry. & Mach. Co., Pittsburgh, Pa.
Sarco Co., Inc., N. Y.

Superheaters
Babcock & Wilcox Co., N. Y.
Heine Boiler Co., St. Louis
Power Specialty Co., N. Y.
Superheater Co., N. Y.

Switchboards
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Switches and Circuit Breakers
General Electric Co., Schenectady

Switch Gear & Metal Clad
Reyrolle & Co., Ltd., A., Hebburn-on-Tyne, England

Tachometers
Biddle, James G., Phila.
Zernickow Co., O., N. Y.

Tanks
Cochrane Corp., Phila.
Erie City Iron Wks., Erie, Pa.
Heine Boiler Co., St. Louis
Littleford Bros., Cincinnati
Smith & Sons Co., S., Paterson, N. J
Union Iron Wks., Erie
Walsh & Weidner Boiler Co., Chattanooga

Tanks, Copper
Hercules Float Wks., Springfield, Mass.

Tape
General Electric Co., Schenectady

Thermometers
American Schaeffer & Budenberg Corp., Brooklyn
Taylor Instrument Co.'s, Rochester

Thermometers, Flue Gas
Bailey Meter Co., Cleveland
Leeds & Northrup Co., Phila.
Taylor Instrument Co.'s, Rochester

Thermometers, Recording
Bailey Meter Co., Cleveland
Bristol Co., Waterbury
Taylor Instrument Co.'s, Rochester

Tramways, Aerial
American Steel & Wire Co., Chicago

Transformers
Allis-Chalmers Mfg. Co., Milwaukee
General Electric Co., Schenectady

Transformers, Speed
Ganschow Co., Wm., Chicago
Transmission Machinery
(See Power Transmission Mach.)

Traps, Compressed Air
Armstrong Mach. Wks., Three Rivers, Mich.
Cochrane Corp., Phila.
Nicholson & Co., W. H., Wilkes Barre

Sterling Engr. & Mfg. Corp., Boston
Templeton Mfg. Co., Boston

Traps, Grease
Armstrong Mach. Wks., Three Rivers, Mich.
Traps, Non-Return
Armstrong Mach. Wks., Three Rivers, Mich.
Sarco Co., Inc., N. Y.
Sterling Engr. & Mfg. Corp., Boston
Templeton Mfg. Co., Boston

Traps, Radiator
Jenkins Bros., N. Y.
Morehead Mfg. Co., Detroit
Sarco Co., Inc., N. Y.
Schutte & Koerting Co., Phila.
Squires Co., C. E., Cleveland
Strong, Carlisle & Hammond Co., Cleveland

Traps, Return
Bundy Steam Trap Co., Nashua, N. H.
Ellis Drier Co., Chicago
Morehead Mfg. Co., Detroit
Sterling Engr. & Mfg. Co., Boston
Templeton Mfg. Co., Boston

Traps, Steam
Amer. Schaeffer & Budenberg Corp., Brooklyn
Armstrong Mach. Wks., Three Rivers, Mich.
Bundy Steam Trap Co., Nashua, N. H.
Cochrane Corp., Phila.
Davis Regulator Co., G. M., Chicago
Ellis Drier Co., Chicago
Nason Mfg. Co., N. Y.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
S.-C. Regulator Mfg. Co., Fostoria, Ohio
Sarco Co., Inc., N. Y.
Squires Co., C. E., Cleveland
Sterling Engr. & Mfg. Corp., Boston
Strong, Carlisle & Hammond Co., Cleveland
Templeton Mfg. Co., Boston
Wright-Austin Co., 321 W. Woodbridge St., Detroit
Yarnall-Waring Co., Mermaid Ave., Phila.

Traps, Superheated Steam
Armstrong Mach. Wks., Three Rivers, Mich.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
S.-C. Regulator Mfg. Co., Fostoria, Ohio

Traps, Vacuum
Armstrong Mach. Wks., Three Rivers, Mich.
Morehead Mfg. Co., Detroit
Sarco Co., Inc., N. Y.
Sterling Engr. & Mfg. Corp., Boston
Strong, Carlisle & Hammond Co., Cleveland
Templeton Mfg. Co., Boston

Tube Cleaners, Boiler
Lagonda Mfg. Co., Springfield, Ohio
Liberty Mfg. Co., Pittsburgh
Rosedale Fdry. & Mach. Co., Pittsburgh
Roto Co., Hartford, Conn.

Tube Cleaners Condenser
Chesterton Co., A. W., Boston
Lagonda Mfg. Co., Springfield, Ohio
Roto Co., Hartford, Conn.

Tube Cutters
Lagonda Mfg. Co., Springfield, Ohio
Tubes, Boiler
Babcock & Wilcox Tube Co., Beaver Falls, Pa.
Boiler Tube Co. of Amer., Pittsburgh
Tyler Tube & Pipe Co., Washington, Pa.
Tubes, Boiler, Charcoal Iron
Tyler Tube & Pipe Co., Washington, Pa.

Tubes, Boiler, Lap Welded
Tyler Tube & Pipe Co., Washington, Pa.

Tubes, Condenser
Wheeler Condenser & Engineering Co., Carteret, N. J.

Tubing
Boiler Tube Co. of Amer., Pittsburgh

Turbines, Steam
Allis-Chalmers Mfg. Co., Milwaukee
Dean Hill Pump Co., Anderson, Ind.
De Laval Steam Turbine Co., Trenton, N. J.
Elliott Co., Wellsville, N. Y.
General Electric Co., Schenectady
Moore Steam Turbine Corp., Wellsville, N. Y.
Ridgway (Pa.) Dynamo & Engine Co.
Sturtevant Co., B. F., Hyde Park
Terry Steam Turbine Co., Hartford
Turbines, Water
Allis-Chalmers Mfg. Co., Milwaukee

Unions and Union Fittings
Bowser & Co., Ft. Wayne
Dart Mfg. Co., E. M., Providence
Jefferson Union Co., Lexington, Mass.

Valve Control, Electric
Liberty Electric Corp., Stamford, Conn.
Pittsburgh (Pa.) Valve Fdry. & Constr. Co.
Valve Disk
Garlock Packing Co., Palmyra, N. Y.
Jenkins Bros., N. Y.

Valve Operator, Electric
Liberty Electric Corp., Stamford, Conn

Valves, Automatic Air
Sterling Engr. & Mfg. Corp., Boston
Templeton Mfg. Co., Boston

Valves, Automatic Cutoff
Elliott Co., Jeannette, Pa

Valves, Back Pressure
Cochrane Corp., Phila.
Davis Regulator Co., G. M., Chicago
Jenkins Bros., N. Y.

Valves, Balanced
Davis Regulator Co., G. M., Chicago
Northern Equipment Co., Erie, Pa.
S.-C. Regulator Mfg. Co., Fostoria, Ohio
Watts Regulator Co., Lawrence, Mass.

Valves, Blowoff
Crosby Steam Gage & Valve Co., Boston
Elliott Co., Jeannette, Pa.
Homestead (Pa.) Valve Mfg. Co.
Jenkins Bros., N. Y.
Lunkenheimer Co., Cincinnati
Powell Co., Wm., Cincinnati
Yarnall-Waring Co., Mermaid Ave., Phila.

Valves, Brass and Iron Body
Bowser & Co., S. F., Ft. Wayne
Homestead (Pa.) Valve Mfg. Co.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Lunkenheimer Co., Cincinnati
National Valve & Mfg. Co., Pittsburgh
Pittsburgh (Pa.) Piping & Equip. Co.
Schutte-Koerting Co., Phila.

Valves, Bypass
Jenkins Bros., N. Y.
Northern Equipment Co., Erie, Pa.

Valves, Check
Cochrane Corp., Phila.
Davis Regulator Co., G. M., Chicago
Greene, Tweed & Co., N. Y.
Jenkins Bros., N. Y.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Lunkenheimer Co., Cincinnati

Valves, Coal Bin
Jeffrey Mfg. Co., Columbus, O.

Valves, Electrically Operated
Lunkenheimer Co., Cincinnati
Pittsburgh (Pa.) Valve Fdry. & Constr. Co.
Valves, Exhaust Relief
Davis Regulator Co., G. M., Chicago
Jenkins Bros., N. Y.
Wheeler Mfg. Co., C. H., Phila.

Valves, Float
Cochrane Corp., Phila.
Davis Regulator Co., G. M., Chicago
Northern Equipment Co., Erie, Pa.
Yarnall-Waring Co., Mermaid Ave., Phila.

Valves, Gate
Greene, Tweed & Co., N. Y.
Jenkins Bros., N. Y.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Lunkenheimer Co., Cincinnati
Pittsburgh (Pa.) Piping & Equip. Co.
Pittsburgh (Pa.) Valve Fdry. & Constr. Co.
Powell Co., Wm., Cincinnati
Rockwell Co., W. S., N. Y.
Wheeler Mfg. Co., C. H., Phila.

Valves, Globe
Crosby Steam Gage & Valve Co., Boston
Jenkins Bros., N. Y.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Lunkenheimer Co., Cincinnati
Powell Co., Wm., Cincinnati
Strong, Carlisle & Hammond Co., Cleveland

Valves, Hydraulic
Homestead (Pa.) Valve Mfg. Co.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Vogt Machine Co., Henry, Louisville
Yarnall-Waring Co., Mermaid Ave., Phila.

Valves, Non-Return Stop
Elliott Co., Jeannette, Pa.
Jenkins Bros., N. Y.
Lunkenheimer Co., Cincinnati
Schutte-Koerting Co., Phila.
Strong, Carlisle & Hammond Co., Cleveland

Valves, Plug
Merco-Nordstrom Co., San Francisco

Valves, Powdered Coal
Furnace Engineering Co., N. Y.
Valves, Pump
Bowser & Co., S. F., Ft. Wayne
Jenkins Bros., N. Y.

Valves, Pump Rubber
Garlock Packing Co., Palmyra, N. Y.

Valves, Reducing
Mason Regulator Co., Boston
Northern Equipment Co., Erie, Pa.
S.-C. Regulator Mfg. Co., Fostoria, Ohio
Squires Co., C. E., Cleveland
Watson & McDaniel Co., Philadelphia

Valves, Regrinding
Lunkenheimer Co., Cincinnati
Powell Co., Wm., Cincinnati

Valves, Regulating
Atlas Valve Co., Newark, N. J.
Mason Regulator Co., Boston
Northern Equipment Co., Erie, Pa.
Pittsburgh (Pa.) Valve Fdry. & Constr. Co.
S. C. Regulator Mfg. Co., Fostoria, O.
Squires Co., C. E., Cleveland

Valves, Relief
Cochrane Corp., Phila.
Lunkenheimer Co., Cincinnati
Northern Equipment Co., Erie, Pa.
Pittsburgh (Pa.) Valve Fdry. & Constr. Co.
S. C. Regulator Mfg. Co., Fostoria, O.
Valves, Safety
Crosby Steam Gage & Valve Co., Boston
Jenkins Bros., N. Y.
Lunkenheimer Co., Cincinnati

Valves, Stop
Jenkins Bros., N. Y.

Valves, Superheated Steam
Bowser & Co., S. F., Ft. Wayne
Jenkins Bros., N. Y.
Lunkenheimer Co., Cincinnati
Pittsburgh (Pa.) Valve Fdry. & Constr. Co.
Schutte-Koerting Co., Phila.
Vogt Machine Co., Henry, Louisville

Valves, Three and Four-Way
Nicholson & Co., W. H., Wilkes-Barre, Pa.

Valves, Two and Four-Way
Nicholson & Co., W. H., Wilkes-Barre, Pa.

Valves, Throttle
Schutte-Koerting Co., Phila.
Valves, Vacuum
Sarco Co., N. Y.

Ventilators
Sturtevant & Co., B. F., Hyde Park

Vises
Curtis & Curtis Co., Bridgeport
Toledo (Ohio) Pipe Threading Machine Co.

Voltage Current Synchronizing
American Brown-Boveri Elec. Corp., N. Y.

Water Columns, Alarm Type
Lunkenheimer Co., Cincinnati
Wright-Austin Co., 321 W. Woodbridge St., Detroit

Water Make-up Plants, Feed
Griscom-Russell Co., N. Y.

Water Purifying Apparatus
Cochrane Corp., Phila.
Graver Corp., East Chicago, Ind.
Griscom-Russell Co., N. Y.
Hagan Corp., Pittsburgh
Paige & Jones Chemical Co., Hammond, Ind.
Permutit Co., N. Y.
Water Softening Apparatus
Cochrane Corp., Phila.
Griscom-Russell Co., N. Y.
Graver Corp., East Chicago, Ind.
Paige & Jones Chemical Co., Hammond, Ind.
Permutit Co., N. Y.

Water Wheels
Allis-Chalmers Mfg. Co., Milwaukee
Worthington Pump & Machinery Corp., N. Y.

Weigh Larries
Webster Mfg. Co., Chicago

Welding Apparatus, Electric
Lincoln Electric Co., Cleveland

Whistles
Lunkenheimer Co., Cincinnati

Wire, Electric
American Steel & Wire Co., Chicago
Wire, Welding
Lincoln Electric Co., Cleveland

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Greene, Tweed & Co., N. Y

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ALPHABETICAL INDEX TO ADVERTISEMENTS

Page

A

Abendroth & Root Mfg. Co.. 62
Acme Magnetic Pulley Co... 54
Air Preheater Corp 42
Alberger Heater Co..... 62
Aldrich Pump Co..... 55
Allen-Sherman-Hoff Co. 54
Allis-Chalmers Mfg. Co..... 77
American Chimney Corp. .. 48
American Engineering Co.. 45
American Pulverizer Co.... 54
American Pipe Bending Mach. Co. 62
American Schaeffer & Budenberg Corp. 64
American Spiral Pipe Works 62
American Steel & Wire Co.. 64
Anderson Engine & Fdry. Co. 37
Andrews-Bradshaw Co. 24
Armstrong Mfg. Co..... 46
Armstrong Machine Works.. 59
Ashland Firebrick Co..... 48
Atlas Valve Co..... 60

B

Babcock & Wilcox Co..... 39
Babcock & Wilcox Tube Co. 41
Bailey Meter Co..... 20
Baker Co., R. H..... 64
Ballard, Sprague & Co..... 41
Beaumont Co., R. H., Front Cover
Bethlehem Steel Co..... 36
Biddle, James G..... 64
Bigelow Arch Co..... 48
Bigelow Co. 39
Blaw-Knox Co. 52
Boiler Engineering Co..... 50
Boiler Tube Co. of America 41
Botfield Refractories Co.... 50
Bowser & Co., S. F..... 13
Brady Conveyors Corp..... 52
Bristol Co. 64
Brown Hoisting Machy. Co.. 54
Buffalo Forge Co..... 48
Buffalo Steam Pump Co.... 55
Bundy Steam Trap Co..... 60
Burke Engineering Co..... 44
Busch-Sulzer Bros. Diesel Engine Co. 36

C

Carborundum Co. 49
Casey-Hedges Co. 39
Cement-Gun Co. 69
Chain-Belt Co. 54
Chaplin-Fulton Mfg. Co.... 58
Chesterton Co., A. W..... 43
Chicago Pneumatic Tool Co. 36
Chuse Eng. & Mfg. Co..... 36
Clarage Fan Co..... 36
Cochrane Corp. 33
CoKal Stoker Corp..... 44
Combustion Engineering Corp. 14-15
Connelly Boiler Co., D..... 40
Cooke Seal Ring 66
Coppus Engineering Corp... 45
Crosby Steam Gage & Valve Co. 65
Curtis & Curtis Co..... 62
Custodis Chimney Constr. Co., Alphons 48
Cyclone Grate Bar Co..... 46

D

Dart Mfg. Co., E. M..... 65
Davis Regulator Co., G. M., Fourth Cover
Dean Bros. Co 55
Dean Hill Pump Co..... 55
De Laval Separator Co..... 67
De Laval Steam Turbine Co. 38
Detroit Stoker Co..... 44
Detrick Co. 51

Page

E

Edge Moor Iron Co..... 38
Elliott Co. .....6-7-3rd Cover
Ellis Drier Co..... 60
Empire Refineries 85
Engineer Co. 50
Engineers' Directory 70
Erie City Iron Works..... 8

F

Flynn & Emrich Co..... 44
Foote Bros. Gear & Machine Co. 75
France Packing Co..... 66
Fuller-Lehigh Co. 12
Fulton Iron Wks. Co..... 35
Furnace Engineering Co.... 44

G

Ganschow Co., Wm..... 75
Garlock Packing Co..... 81
Garratt-Callahan Co. 41
Gas Combustion Co..... 38
General Electric Co.....10-11
General Refractories Co.... 48
Gifford-Wood Co. 54
Graver Corp. 41
Green Fuel Economizer Co.. 42
Greene, Tweed & Co., Fourth Cover
Griscom-Russell Co. 29

H

Hagan Corp. 45
Harrisburg Fdy. & Machy. Wks. 38
Hanson, Roy E..... 64
Hart Stoker, Ltd. 44
Hays Institute 69
Hayward Co. 52
Heine Boiler Co..... 39
Hercules Float Works..... 48
Hofft Co., M. A..... 44
Homestead Valve Mfg. Co.. 61
Hoppes Mfg. Co..... 44
Howard Iron Works..... 62
Hoyt Metal Co..... 43
Hunt Co., C. W..... 52
Huyette Co., Paul B..... 42

I

Illinois Stoker Co..... 44
Ingersoll-Rand Co. 17

J

Jefferson Union Co..... 21
Jeffrey Mfg. Co..... 16
Jenkins Bros. 4
Jones Fdry. & Mach. Co., W. A. 83

K

Keasbey & Mattison Co..... 32
Kelly Foundry & Machine Co. 46
Kennedy Van Saun Mfg. & Eng. Corp. 53
Kennedy Valve Mfg. Co.... 62
Keystone Refractories Co.. 48
King Refractories Co..... 50
Kingsford Fdry. & Mch. Wks. 38

L

Laclede-Christy 48
Laclede Stoker Co..... 44

Page

Ladd Water Tube Boiler Co. 38
Lagonda Mfg. Co..... 40
Lecourtenay Co. 55
Leeds & Northrup Co., Second Cover
Libbey Glass Mfg. Co..... 40
Liberty Electric Co..... 62
Liberty Mfg. Co..... 40
Lincoln Electric Co..... 79
Link-Belt Co. 3
Linde Air Products Co..... 26
Liptak Fire Brick Arch Co.. 48
Littleford Bros. 45
Lombard Governor Co..... 36
Lunkenheimer Co. 9

M

McClave-Brooks Co. 25
McGraw-Hill Book Co..... 69
McIntosh & Seymour Corp.. 34
McLeod & Henry Co..... 50
Magnetic Mfg. Co..... 52
Manistee Iron Works Co... 58
Mason Regulator Co..... 58
Mettler Co., Lee B..... 45
Midwest Piping & Supply Co. 62
Milwaukee Electric Crane & Mfg. Corp. 58
Mogul Mach. Co..... 62
Moore Steam Turbine Corp. 38
Morehead Mfg. Co..... 60
Morse Chain Co..... 75
Morse Dry Dock & Repair Co. 45
Morris Mach. Wks..... 58

N

Naismith & Son, Geo..... 42
Nason Mfg. Co..... 59
National Airoil Burner Co.. 45
National Valve & Mfg. Co.. 62
N. Y. Belting & Packing Co. 75
Neemes Foundry, Inc..... 48
Nicholson & Co., W. H..... 60
Nordberg Mfg. Co..... 38
Northern Equipment Co.... 5
Nugent & Co., Wm. W..... 64

O

Obermayer Co., S..... 50
Ohio Grease Co..... 66

P

Paige & Jones Chemical Co. 41
Patterson-Kelley Co. 66
Peabody Engineering Corp.. 45
Peale, Peacock & Kerr..... 55
Penberthy Injector Co..... 59
Permutit Co. 27
Philadelphia Gear Works... 74
Pittsburgh Coal Co..... 54
Pittsburgh Piping & Equipment Co. 62
Pittsburgh Valve Foundry & Construction Co. 62
Platt Iron Works..... 58
Plibrico Jointless Fire Brick Co. 50
Powell Co., Wm..... 60
Power Piping Co..... 62
Power Specialty Co..... 42

Q

Quaker City Rubber Co.... 58

R

Republic Flow Meters Co..22-23
Reyrolle & Co., Ltd., A..... 68
Rhoads & Sons, J. E..... 75
Ridgway & Fils Co., Craig.. 75

Page

Ridgeway Dynamo & Engine Co. 38
Riley Stoker Corp..... 44
Robins Conveying Belt Co.. 54
Rosedale Fdry. & Mch. Co.. 44
Roto Co. 42
Rust Engineering Co..... 48

S

Sarco Company 59
Sauerman Bros. 54
S. C. Regulator Mfg. Co.... 57
Schutte & Koerting Co...60-64
Searchlight Sections 71-73
(See alphabetical index listed below)
Skinner Engine Co..... 38
Smith & Son Co., Samuel... 38
Smoot Engr. Corp..... 45
Smooth-On Mfg. Co..... 31
Spray Engineering Co..... 58
Springfield Boiler Co..... 38
Squires Co., C. E..... 60
Sterling Engine Co..... 37
Sterling Eng. & Mfg. Corp.. 60
Strong, Carlisle & Hammond Co. 59
Sturtevant Co., B. F..... 42
Superheater Co. 30

T

Taylor Instrument Co.'s.... 64
Templeton Mfg. Co..... 60
Terry Steam Turbine Co.... 38
Timken Roller Bearing Co.. 47
Toledo Pipe Threading Machine Co. 65
Troy Eng. & Mach. Co. 36
Tyler Tube & Pipe Co..... 41

U

Underwood Corp., H. B..... 38
Union Iron Works..... 40
United Conveyor Corp..... 52
United States Graphite Co.. 66
United States Rubber Co... 66

V

Vogt Machine Co., Henry... 63
Vulcan Soot Cleaner Co.... 40

W

Wailes-Dove Hermiston Corp. 75
Walsh & Weidner Boiler Co. 39
Walsh Fire Clay Products Co. 48
Warren Steam Pump Co.... 56
Watts Regulator Co..... 60
Webster Mfg. Co..... 52
Wheeler Condenser & Engineering Co. 58
Wheeler Mfg. Co., C. H.... 28
Wickes Boiler Co..... 40
Wing Mfg. Co., L. J..... 50
Worthington Pump & Machy. Corp. 56
Wright-Austin Co. 59

Y

Yarnall-Waring Co. 18-19
York Mfg. Co..... 66

Z

Zernickow Co., O..... 64

INDEX TO SEARCHLIGHT SECTION

Belyea Co., Inc. 73
Consolidated Products Co.. 71
Fuerst Friedman Co. 73
Lagonda Mfg. Co. 71
Land, L. J. 73
Lippincott Co. 72
Moore & MacDonald 73
Nashville Industrial Corp., 71-72-73
O'Brien Machinery Co. 72
Phoenix Utility Co. 73
Positions Vacant and Wanted 71
Randle Machinery Co. 72
Rockford Power Mchy. Co.. 73
Ross Power Equipment Co.. 72
Sachsenmaier Co., George.. 73
Scheinert Co., R. 73
Schwartz Boiler Co., C. M.. 73
Wilson Mchy. Co., Harold R. 73